PRONTOSIL DOES IT STAND?

Complete ✓ II

SCIENTIFIC AMERICAN

January · 1938

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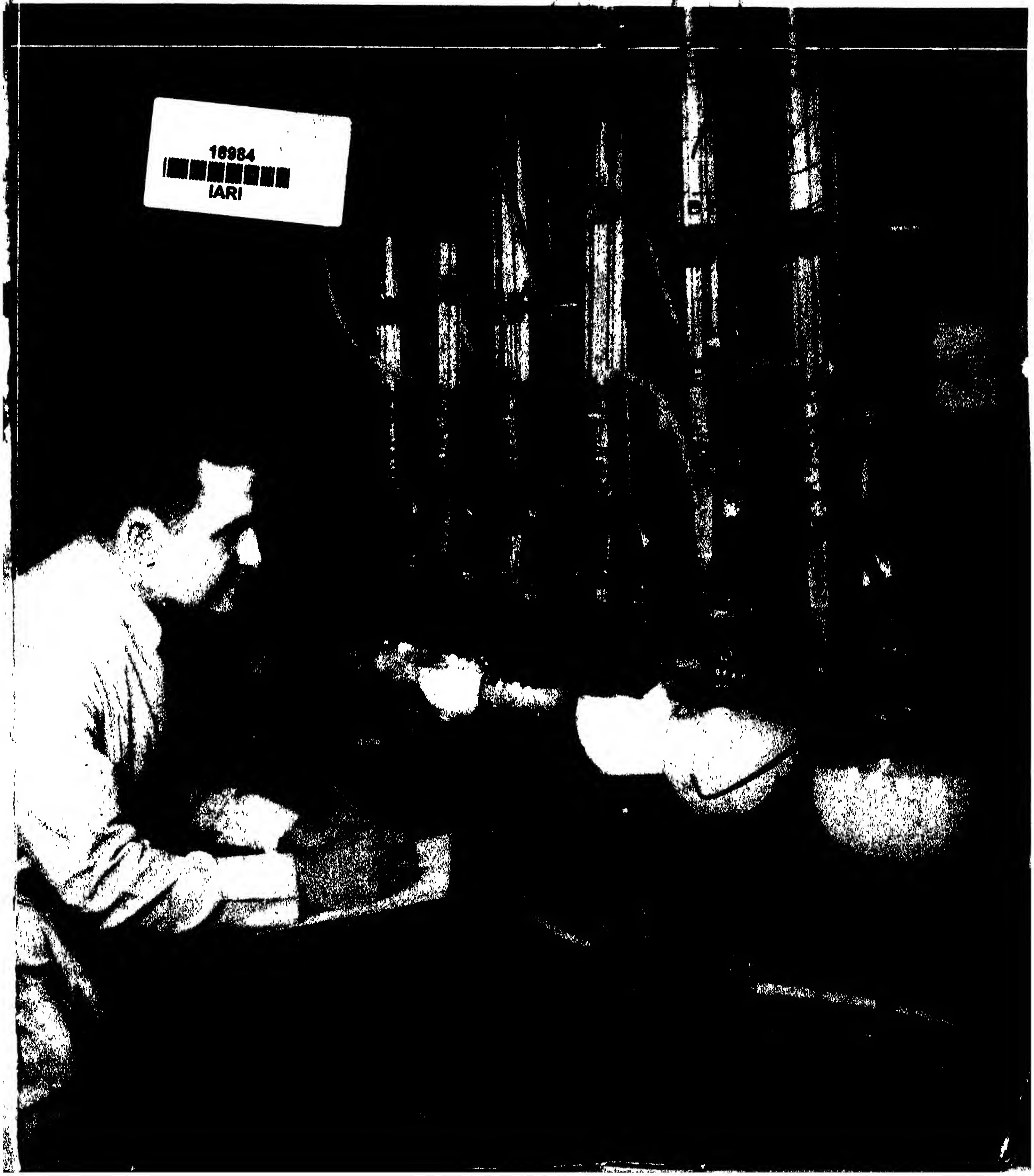

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

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THE point at which the ingredients of the plastic Catalin (see pages 18 and 19) "kick over" from a liquid and gas to a solid material occurs quickly, and the slightest variation in ingredients or processing would cause undesirable results. As in all chemical processes, every phase in the production of plastics must be kept under close laboratory observation in order to avoid trouble. Our cover photograph shows a laboratory technician making tests of the ingredients of a plastic to be sure that they meet pre-determined specifications.

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SCIENTIFIC AMERICAN, January, 1938. Vol. No. 158. No. 1, entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1888)

SUB-SEA PHONE—"Lieutenant Boyer, of H. M. S. Malabar, has recently been experimenting in telephonic communication at sea. The signaling apparatus of his invention consists of a gong fixed against the side of the vessel below the water line. A straight tube leads from this gong to the bridge, and in its interior is a rod, by which the hammer can be worked, and the striking may be in accordance with the Morse code. In the center of the gong is fixed a telephone. . . . This forms the receiver. If two ships be fitted with this combination, it is maintained that it is only necessary for one to rap out her message by striking her gong and for the other to receive it on her telephone. The sound waves from the transmitting gong traverse the intervening water and vibrate the diaphragm of the submerged telephone at a distance."

MASTODON—"The mastodon, that great fossil mammal, allied somewhat nearly to the elephant, has become, perhaps, more familiar to the public than any other of the numerous great creatures which once lived in our extended country. This familiarity came about through the frequent discovery of well preserved skeletons of the mastodon. . . . The most perfect, and also the most remarkable, as to size and interesting developments, is the skeleton of a mastodon now mounted in the Geological Hall of the American Museum of Natural History, in Central Park. This example, of which our engraving is a correct picture, was found embedded in a peaty material in the town of Salisbury Mills, near Newburgh, New York."

CHANNEL BRIDGE—"The following details of a proposed bridge across the English Channel are taken from a French contemporary. . . . The plans have already been prepared, and are at present being examined by skilled engineers at the Creusot Works. . . . It is estimated that the cost will be somewhere about 40,000,000 pounds, and the time required before it can be completed seven years or more. The course proposed to be taken for the bridge is from Cran-aux-Oeufs, a little place on the French coast between Ambleteuse and Cape Gris Vert, to Folkestone, on the English side, a distance of about 22 miles. Not the shortest, but the shallowest line will be chosen. . . . The piles required are blocks of concrete and masonry, 160 feet long by 100 broad, and will be placed at intervals of about 550 yards. . . . The causeway of the bridge will be about 160 feet above the sea level, so that vessels of any size may be able to pass beneath it. . . . Such are the outline details of this enormous undertaking, which the projectors state they have full confidence will be before long carried out."

CHOLERA—"An illustration of the practical usefulness of bacteriology was furnished recently in this city. An Italian steamer arrived loaded with immigrants. There had been no cholera on board, but, as the vessel reached this port, a suspicious case of diarrhoea occurred in a child. The symptoms were not perfectly typical of cholera. Some of the dejections were taken, and sterilized tubes were inoculated and taken to the Carnegie Laboratory in this city. . . . The cultures developed in the way characteristic of Asiatic cholera, and the diagnosis was made. Subsequently other cases of cholera appeared, and the culture diagnosis was abundantly confirmed."

SOLAR PLATINUM—"Professor C. C. Hutchins and Professor E. L. Holden, of the Harvard University Physical Laboratory, have begun a most interesting work pertaining to observations on the chemical constitution of the sun, which have already led to some remarkable results. . . . One result of these researches . . . is the discovery of platinum in the sun."

VACCINATION—"The success of anti-vaccination is aptly shown by the results in Zurich, Switzerland, where, for a number of years, until 1883, a compulsory vaccination law obtained, and smallpox was wholly prevented—not a single case occurred in 1882. This result was seized upon in the following year by the anti-vaccinationists, and used against the necessity for any such law, and it seems they had sufficient influence to cause its repeal. The death returns for that year (1883) showed that for every 1,000 deaths, 2 were caused by smallpox; in 1884, there were 3; in 1885, 17; and in the first quarter of 1886, 85."

AIRSHIP—"A vessel for aerial navigation, which is designed to be a light and yet strong and roomy structure, capable of easy ascension and being readily steered . . . is constructed with a series of longitudinal tubes, adapted to hold concentrated gas, and bent to assume a generally spherical shape. . . . An outer smooth metallic wall is also provided, having a sharp forward point, in which is a sight opening, a steering apparatus being mounted near by. In the central portion of the ship is a compartment, in sub-divisions of which are electric motors to furnish propelling power, the wings being designed to partake somewhat of the appearance of a bird's wing, the upper row of wings propelling the ship forward and slightly upward, while the dip and stroke of the wings may be adjusted within certain limits. The rudder is made somewhat in the shape of a fish tail, and consists of two fans arranged side by side in the same plane. The ship is elevated principally through the introduction of the concentrated gas in the longitudinal tubes into the gas chambers."

TRACKS—"According to the *Railway Age*, the year 1887 has surpassed all other years in the extent of railway mileage constructed in the United States."

SUBMARINE—"Lieutenant Hovgaard, of the Danish navy, . . . gives a description of a submarine boat which he has designed, which shall be able to dive below the surface at any moment, continue her course under water for a considerable distance, and remain there for many hours, retaining the while her capacity for continuing her work. For driving her machinery he employs steam above water and electricity in stowage (*sic*) batteries under water."

AND NOW FOR THE FUTURE

Paranoid personalities, by Paul Popenoe, Sc.D.

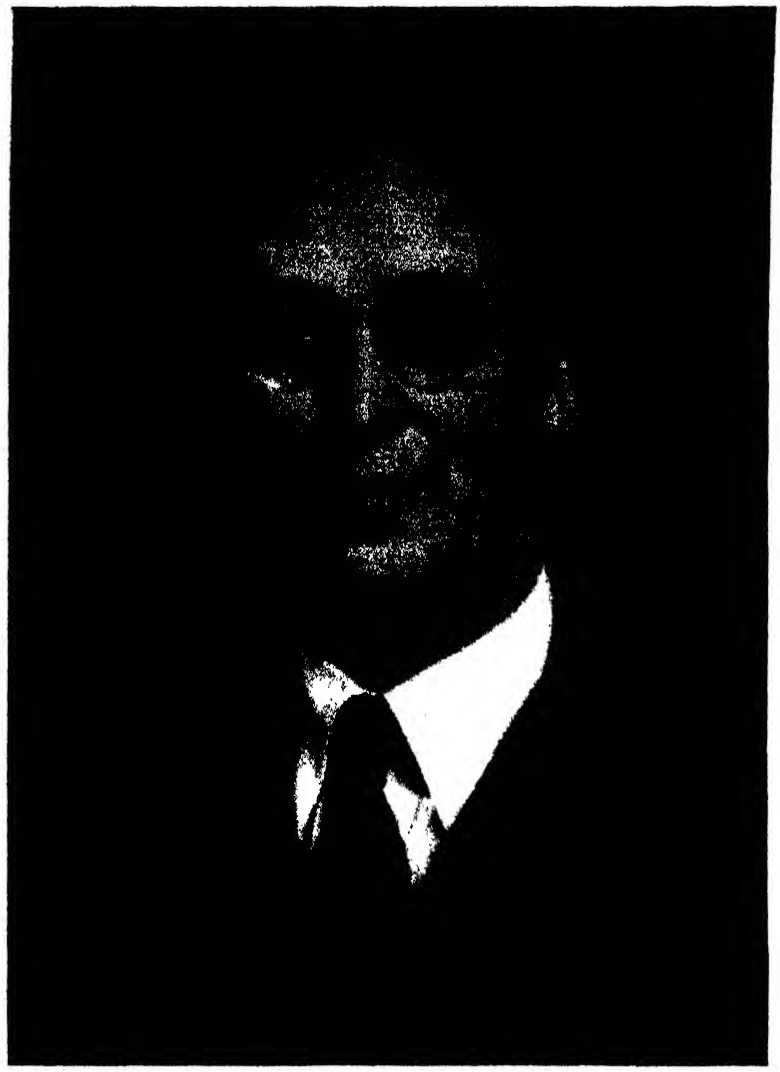
Dental records to identify the dead, by Edward J. Ryan, B.S., D.D.S.

How a Clipper plane is built—told in photographs.

The chemistry of alloys, by Prof. Sidney J. French.

Power from bacteria, by M. K. Elwood.

Personalities in Industry



DR. JOHN JOHNSTON

IN 1927 Dr. John Johnston was called from Yale University, where he was Sterling Professor of Chemistry and Chairman of the Department, to set up a research laboratory for the United States Steel Corporation. A combination of factors, chief among which was an appreciation of future trends, had resulted in a plan to establish a central research laboratory which would deal with major problems affecting all products made by the several subsidiary companies and aim to coordinate the investigations being carried out in the many plants and laboratories of those companies.

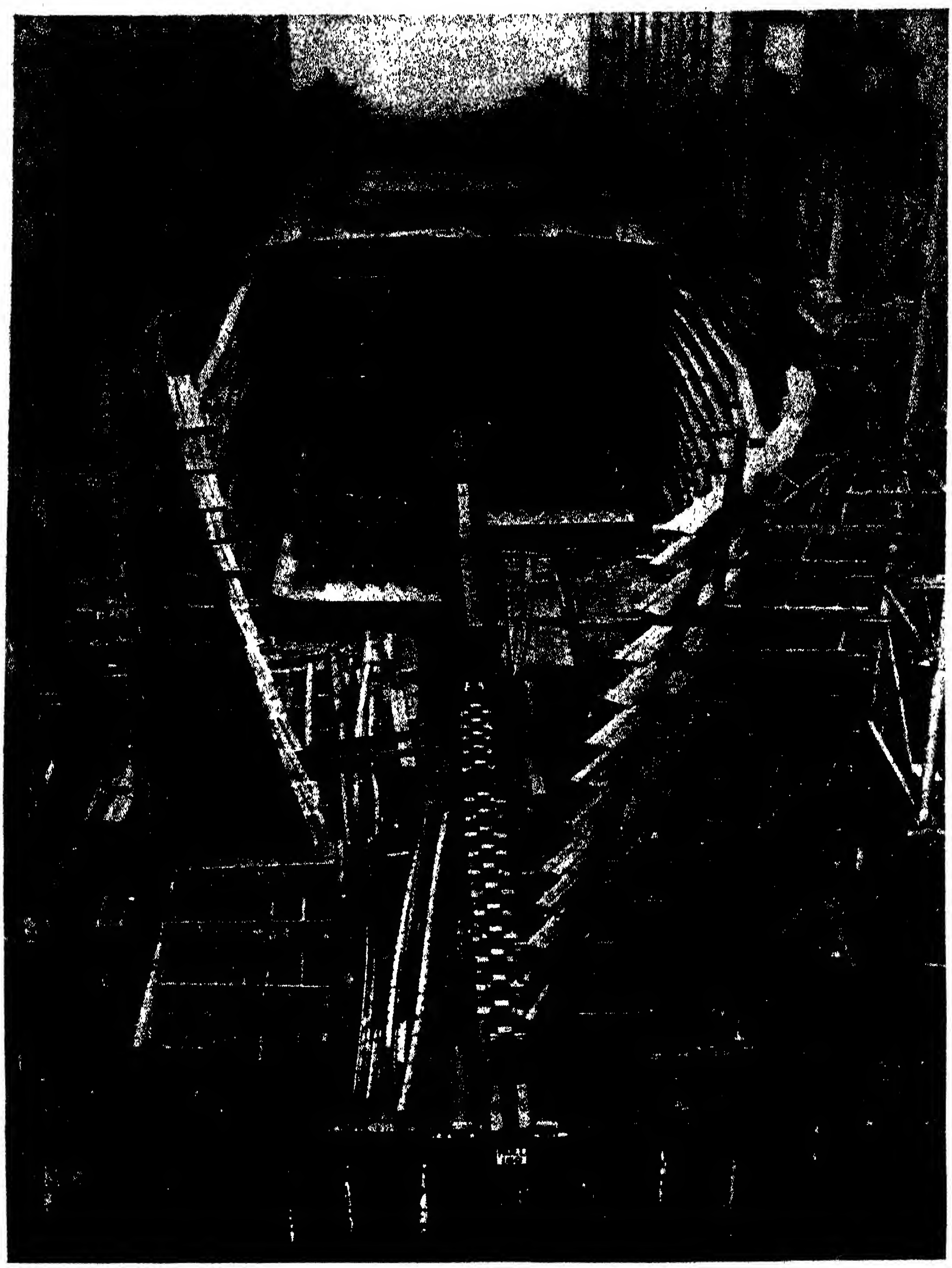
The laboratory was started, late in 1928, in Kearny, New Jersey, with a staff of metallurgists and physical chemists who began by surveying the possibilities of improving the quality, and fitness for its purposes, of steel. The primary investigations on which are based the subsequent applications to practice comprise many of a type commonly spoken of as "pure research"; that is, research planned to yield some definite knowledge which may or may not be directly applicable to present-day practice. Many of them have been described in scientific and technical journals, the list of publications now comprising more than 80 papers.

In his papers and lectures discussing the science of steel-making, Dr. Johnston has dealt mainly with the complex chemical and physico-chemical problems connected with the production of steel and the behavior of finished steels. He believes that while heretofore the ancient art of steel-making has been ahead of the science, further marked progress in the furnishing of the steel preëminently suited to each of the multifarious uses of steels will be possible through the further progress in establishing the scientific basis for all of the steps in the process. Among others, the chemical manufacturing industry and the transportation industries have greatly benefited by the development of improved steels with a combination of properties which suits them for special uses.

Born in Perth, Scotland, October 13, 1881, Dr. Johnston studied at Perth Academy, then entered the University of St. Andrews from which he was graduated with the B.Sc. degree in 1903. By examination he was admitted as an Associate of The Institute of Chemistry of Great Britain in 1903. In the same year he was awarded a Carnegie Scholarship in Chemistry which gave him opportunity to do research work with Professor James Walker from 1903 to 1905. In 1905 he was awarded the 1851 Exhibition Scholarship for two years which he spent at the University of Breslau, Germany, working with Professor Abegg. During 1907-08 he was Research Associate in the Laboratory of Physical Chemistry of the Massachusetts Institute of Technology, working with Professor A. A. Noyes upon the conductivity of aqueous salt solutions.

In 1908, he received the degree of Doctor of Science from St. Andrews University. The following year he joined the staff of the Geophysical Laboratory in Washington as chemist, where he was occupied with investigations in the fields of high temperatures and of high pressures directed toward the solution of some geological problems. In 1916, he left to take charge of the Research Department of the American Zinc, Lead and Smelting Company, in St. Louis, where he was engaged in an endeavor to effect economies in the production of zinc and its by-product, sulfuric acid. During the war period he served the U. S. Bureau of Mines on war gas investigations. In 1918-19, he was Secretary of the National Research Council and Chairman of the Chemistry Division. Following this, he joined the Chemistry Department of Yale University, becoming Sterling Professor of Chemistry and Chairman of the Department. Since 1927, he has been with the United States Steel Corporation as Director of Research. Honorary degrees have been awarded to Dr. Johnston from Yale University (M.A. 1919); New York University (D.Sc. 1928); Lehigh University (D.Sc. 1929).

Dr. Johnston has been a prominent and active member of a number of scientific organizations, among which are the American Chemical Society, of which he is now a councillor-at-large, and the American Electrochemical Society, of which he was president in 1933-34.



WELDING DOES ITS BIGGEST MARINE JOB

SINCE its first experimental application to the construction of ships a comparatively short time ago, welding has advanced greatly. This tanker, on the ways at Chester, Pennsylvania, will be the largest welded ship ever built. With a cargo capacity of 156,000 barrels, it will carry for its owners, The Atlantic Refining Company, more oil in one load than was produced in any one day from 1878 to 1909. Its length will be 521 feet and its tonnage 18,500. Turbo-electric engines developing 5000 horsepower will give the tanker a speed of over 13 knots. Since this picture was taken, the tanker has been launched.

The trumpeter swan, a magnificent North American waterfowl, persists in small numbers despite man's advance

All illustrations courtesy U. S. Bureau of Biological Survey

Conservationists recognized that the end of the buffalo was approaching, and took steps to protect the animals

What Can We Do About Our Rare and Vanishing Species?

Lessons Have Been Taught by the Disappearance of the Passenger Pigeon and Heath Hen . . . A Greater Public Interest and Support Needed

By IRA N. GABRIELSON

Chief, Bureau of Biological Survey
U. S. Department of Agriculture

THE problem of our vanishing species of wildlife stirs a great deal of scientific as well as popular interest. Scientists read from the records of the rocks that whole faunas have vanished from the earth not once but at various stages in geologic history; we cannot even guess at the numbers that disappeared without leaving any permanent record behind them. Since rather peculiar combinations of conditions are required for the preservation of animal remains, as well as for another series of geological events, such as elevation by upheaval of the rocks to the surface and erosion that cuts down to reveal the fossil belts, it is a safe guess that the ancient creatures we know of now can be only a small part of the whole assembly of vanished American animals.

We cannot say with any certainty what exterminated them nor can we today say why the ivory-billed woodpecker has practically gone while the smaller pileated woodpecker, similar in at least some of its living habits, has held its own much better. Nor can we definitely state why the Eskimo curlew is gone but other similar forms still persist in some numbers. We do know that invasion by man, with his agricultural needs for new lands to exploit, has destroyed the original homes of some species. This has undoubtedly been a major factor in the decline of the whooping crane and the trumpeter swan almost to the vanishing point, but we cannot be certain that it is the *only* factor. Other creatures, such as the prairie chicken and the sharp-tailed grouse, were decimated by overshooting as well as by a rapidly decreasing area of natural range. We know that man and his various activities played a major part in the extermination of some animals that have vanished in comparatively recent times. This very fact has had the effect of creating the hope that it will be possible to prevent such occurrences from happening again.

YEARS ago the Carolina paroquet disappeared and no one realized it until it was too late to do anything but express regret. In July, 1914, the last surviving passenger pigeon died in the Cincinnati Zoo. The death of this last member of a little group of captive birds wrote finis to a species whose numbers were once so great as to darken the sun as they moved across the country in their migratory flights. The passing of this bird provoked a great deal of interest and rather widespread newspaper comment, not only at the time but at intervals since. So sudden and so complete was the demonstration of the doom of the pigeon that to many observers it had a savor of the mystery of the preternatural.

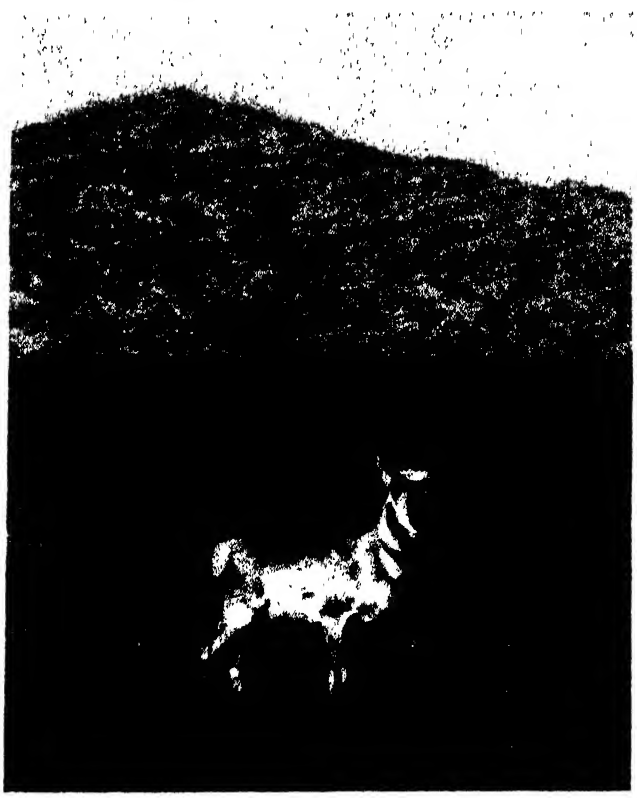
Season after season the countless millions of passenger pigeons had returned to the incredibly teeming confusion of the pigeon roosts, and then within the space of but three or four years they were gone and with a suddenness that was catastrophic. A few doomed and dwindling flocks remained to experience a brief stay of execution, but soon all had vanished forever. People who wit-

nessed the tragedy could not convince themselves that it had occurred. The birds, they said, had migrated to South America or they had founded new colonies in remote and inaccessible regions in the Rockies, or in Canada, or on some sea island from which retreat they would some day return, a mighty host, to astonish and delight later generations of Americans. With diminishing frequency the Biological Survey continues to receive communications from individuals who saw these hosts in the days of their abundance, each of whom believes he has discovered a flock of passenger pigeons. For a good many years following the disaster, the more convincing of these reports were investigated, but the results were always the same; whatever the investigator found it was not the passenger pigeon. The rewards, amounting to some thousands of dollars, offered for positive proof that even a single pair of the birds still exists have never been bestowed—and we know now that they never will be.

THERE will probably always be some mystery about the final disappearance of the passenger pigeon but students generally agree that man's invasion of their habitat was an important if not *the* all-important factor. Market hunting destroyed millions and the cutting of forests and opening up of agricultural land undoubtedly disturbed the natural relations of the birds to their environment. This last factor alone may have been sufficient to prevent any recovery of a species already greatly reduced in numbers. Whether these two or some of the other explanations advanced are the real answer may never be known, but it is generally accepted that man, both directly and indirectly, contributed mightily to the disappearance of the teeming millions of these birds.

About five years ago the last heath hen on Martha's Vineyard disappeared; this meant the extermination of this eastern form of the prairie chicken, a loss which did not occur, however, without a real effort on the part of conservationists to save this bird. Massachusetts people put time, money, and effort into the program to save the heath hen, but the action came too late to be successful. I think that in the history of these three species might be read the evolution of the interest of Americans in preserving their wildlife resources. I can see a change from absolute indifference to a live and active interest in the problem of vanishing species.

The buffalo came very close to going the same route, but energetic action and the spending of considerable sums of money by a few individuals prevented that, and no one now worries about the future of the buffalo, although it is probably beyond reasonable hope that any great number of them can ever again range freely in this country. Still the species is preserved, both in the United States and in Canada, on government preserves and by private individuals. There are in the western states three great federal buffalo ranges—one in Montana, one in Nebraska and one in Oklahoma—as well as several National Parks on which are kept stocks of this once almost innumerable inhabitant of the western plains.



The tide was turned in favor of the pronghorn antelope by a deficiency of rainfall that stopped man's plow

A few years ago a combination of wet years in the arid sections of the country and the 640-acre homestead act nearly sent the antelope, that fleet inhabitant of the plains country, to join some of the other extinct species. Today, great antelope refuges have been set aside in the western states where, except for some improbable natural catastrophe, it should be possible always to preserve the herds. Antelope cannot withstand human settlement of their home ranges and the long continued deficiency in rainfall in these semi-arid areas, which stopped the plows and reversed the trend of human population, was a boon to the antelope, whatever it meant in human suffering. The antelope are now so numerous in western states that several restricted open seasons have been declared, during which carefully managed hunts are allowed. Other states are considering similar action. There are many times the number of antelope living on the western plains today that there were 15 years ago. It is not too wildly fantastic to say that there is some possibility of this species becoming too abundant in some areas as deer have become in numerous spots in the United States, and that the probable concern of those interested in this particular form of wildlife will in the near future be directed to limiting the number to the available food supply rather than to efforts further to increase the herds.

THESE few examples reflect the possibilities of preserving and restoring species of wildlife. The first efforts in this direction failed, probably because they came too late. With the buffalo, the efforts were successful in preserving the species, and with the antelope the combination of conditions and public interest has resulted in an increased population over a wide range. For other species the story is not such a happy one as in the case of the antelope, nor so beyond hope as in the case of the passenger pigeon, the Carolina paroquet, and the heath hen.

Let us review just a few of the species whose numbers are at such a low ebb that they might encounter extermination as a result of any unfavorable change in conditions.

The whooping crane, once a very common bird which bred from Nebraska, Iowa, and the Dakotas northward into Canada, and which up to 50 or 60 years ago could be counted by the thousands in flight, is making its last stand. Whether it can be saved or not is a question, but an effort is being made. There has been close and whole-hearted co-operation between the governments of the United States and Canada in an effort to save the few individuals left. These birds breed in certain areas in Canada which are being carefully guarded by the Canadian government. Every effort is being made to protect the survivors while they are in the United States, and one area in southern Louisiana and another on the Texas coast, frequented by these great white cranes during the winter, will shortly become federal refuges. Both of these refuges, which were purchased primarily for winter homes for ducks and geese, will also give protection to the surviving cranes so long as they remain on them. Another little group of whooping cranes is known to winter in certain inaccessible areas in Mexico. Perhaps complete protection of these birds on both their wintering and summering grounds may yet

give them a chance, but their numbers are woefully small and it is still a question whether the efforts to save this bird have been undertaken in time to prove a success.

The California condor is another species in grave danger. Whether any measures which may now be undertaken will succeed in preserving it is still problematical. The point of interest is that intelligently directed efforts are being made to aid the species. An area on one of the California national forests which is known to be the home of the only surviving group of these great birds has been put under a special closing order and is being zealously guarded by the National Forest Service in an effort to give the condors an undisturbed opportunity to breed and restore their numbers.

THE trumpeter swan, the most magnificent of North American waterfowl, still persists in small numbers in British Columbia, in Yellowstone Park, and in the mountains of south-central Montana. Red Rock Lake, one of the newer federal waterfowl refuges, is the main breeding ground for these birds in the western United States. It is an ideal territory for their use and on this refuge and on lakes in Yellowstone Park this great bird is making its last stand in the United States. Formerly it bred from Iowa and Nebraska northward throughout much of the prairie country in Canada, as well as on the mountain lakes in much of the northern United States and southern Canada.

Swans of both the North American species, namely the trumpeter and the whistling, have been protected for years by the federal migratory bird law as well as by a very strong popular sentiment for their preservation. The whistling swan, with its breeding ground beyond the Arctic Circle, has responded magnificently and it is again possible to see flocks of these swans, numbering not only hundreds but actually thousands of birds; the species appears to be well on the way toward recovery on both the Atlantic and the Pacific coasts. As an example of the numbers that may be found, the following from the 1936 report of the Superintendent at Lake Mattamuskeet Bird Refuge in North Carolina is interesting: "The net results of three separate counts and constant observations by our patrol force indicate there are 15,000 whistling swans."

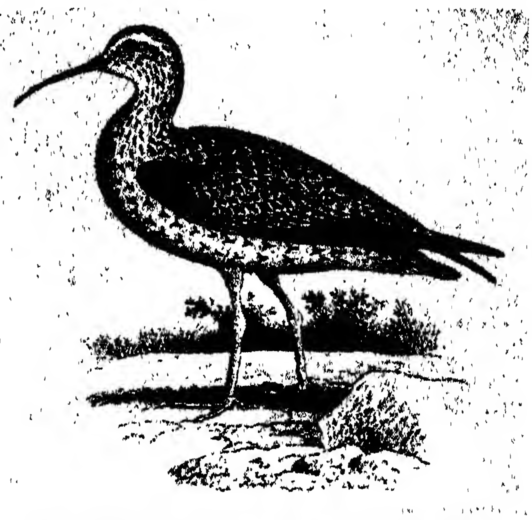
The trumpeter, with a more southerly nesting ground, and more sedentary habits, has not been so fortunate, and has practically vanished. However, there is still hope that present constructive efforts have been started in time to save it. Counts of breeding birds on Red Rock Lake and in Yellowstone Park are interesting. For the breeding seasons of 1935, 1936, and 1937 we have the following careful checks:

	1935	1936	1937
Number of adult trumpeter swans on Red Rock Lake Refuge	28	31	39
Number of young trumpeter swans on Red Rock Lake Refuge	16	26	51
Number of adult trumpeter swans in Yellowstone Park	—	43	42
Number of young trumpeter swans in Yellowstone Park	—	15	26
Total number of trumpeter swans observed in Yellowstone Park and on Red Rock Lake	--	115	158

Strenuous efforts were made to save the heath hen, but its numbers had been too far decimated

The great ivory-billed woodpecker, formerly widely distributed in southern forests and swamps, is now scarcely more than a memory, although scattered colonies exist in a few states along the Gulf Coast. There may still be a chance to save this species as there are a few birds left in the vicinity of one of the newer federal refuges and individuals have occasionally been seen on or near this sanctuary. The area involved is the great Okefenokee swamp in southern Georgia, about two thirds of which is now in a federal wildlife refuge and being administered solely for the protection of wildlife. Every effort is being made to preserve as much of the primitive wilderness as is left there, although fire and logging have left great scars on the swamp which will take years to heal. Conditions there are favorable for the birds and it is hoped that this little group can be preserved.

This refuge, incidental to its purpose of serving as a wintering ground for certain groups of waterfowl, particularly wood ducks and ring necked ducks, will also protect a colony of breeding Florida sandhill cranes, the small black bear of the South, the otter, and various other species that were becoming perilously close to extirpation.



The Eskimo curlew is gone, although similar forms of wildlife still persist in numbers

The big white herons which were practically exterminated at one time in south Florida are slowly increasing in numbers on the Florida Keys. The National Association of Audubon Societies has been patrolling these areas trying to protect the birds, and the Biological Survey is making an effort to provide a refuge that will give protection to the main nesting colony. This is not an accomplished fact, however, and when it does come it may be too late to save the birds.

THE situation is not so favorable for some of the shore birds because the birds leave this continent. The Eskimo curlew, that formerly migrated as far south as Argentina, is probably extinct. Some of the others that make the same trip, such as the golden plover and the so-called upland plover or Bartramian sandpiper and Hudsonian godwit, are perilously close to extermination. They have been killed off for human food and great reaches of their habitat destroyed by cultivation and drainage. The Hudsonian curlew, and two species of yellowlegs, also among the globe-spanners, and the long-billed curlew of lesser taste for travel, while still fairly numerous, cannot be said to be safe.

However, the protection and restoration of breeding grounds in the prairie states which are coming as a result of the

Young antelope doe and buck on a Nevada game refuge

intensified refuge program and which will be further accentuated by an extension of the back-to-grass movement in that territory, have meant new chances for some of these birds. On one federal refuge in Nebraska, 800 pairs of long-billed curlews were reported as nesting last year, and these birds are present and nesting on a number of other refuges in very satisfactory if somewhat limited numbers. The number of Hudsonian curlew coming down on the coast from their northern breeding grounds also has been slowly increasing.

The extension of the refuge system to some of the great coastal marshes on the south Atlantic, Texas, and Gulf Coasts has been of great incidental value to shore birds. On these great refuges, which sometimes extend for miles along the coast, the birds find complete protection and a chance to rest and feed, of which they take full advantage. There is no question as to the marked increase in the number of willets, and a distinct but smaller growth in those of some of the other shore birds.

THE greatest obstacle, aside from overshooting, to the preservation and increase of the long distance travelers among the shore birds, is the plowing up of their South American wintering ground for the purpose of growing cotton and corn. This seriously disarranges their habitat and decreases the possibility of restoring these birds to even a fraction of their former numbers. It will require concerted action by several South American countries to insure the perpetuation of the flight of some of the finest of our shore birds.

The Attwater prairie chicken, a distinctive species found in a few coastal counties in Texas, has been gradually approaching the danger line, but there is now hope of doing something about it. The last session of the Texas legislature passed a law closing the season on these birds for five years, and definite studies of their needs are being made by the Cooperative Wildlife Research Unit at Texas Agricultural and Mechanical College. This unit, which represents the combined efforts of the College, the State Fish, Game, and Oyster Commission of Texas, the Biological Survey, and the American Wildlife Institute, is making a study of the needs of this bird and the possibility of restoring it. Out of these studies we may hope for a definite program which will give it a chance if there is any hope.

Mammals that have been seriously threatened include several species of whales which are now protected by an international treaty recently signed by 27 countries. This treaty and the publicity which has been given it may very well be the turning point in the history of these great marine mammals, although some of them are dangerously near the disappearing point.

Nelson's mountain sheep, one of the desert forms of this most interesting group of the larger North American mammals, have been reduced to pitifully small numbers. A few individuals surviving on scattered desert mountain ranges are all that are left, but positive steps are being taken to preserve them. A great refuge covering three mountain ranges which still have a small population of these animals has been set aside in southern Nevada and is now being placed under administration, primarily for the protection of this single, but most interesting, form of American wildlife.

No satisfactory solution has yet been found to the problem of preserving the fisher, wolverine, marten, and other fur animals that have been reduced to a very low level because of overtrapping. Long closed seasons, adequately enforced, appear to be the only chance of building up the numbers of these animals, but prospects would be better if the market for them could be simultaneously suspended.

Several of the rarer species of hawks and kites are at a very low ebb, due largely to the prevalent American custom of shooting every hawk that comes within sight, on the very convenient but erroneous theory that the man who kills a hawk is doing a good deed in a naughty world. In most instances it is just the opposite of this, and the deed is a very bad one. Whether anything can be done to change this psychology to a more practical and truthful consideration of the subject is a question. Reams have been written and propaganda put out for nearly 50 years on the value of certain species of hawks and owls, yet the average farmer or hunter continues to kill them whenever opportunity affords. A great majority of the states have passed laws protecting all but a limited number of species of hawks known to be destructive to game birds or animals or to domestic livestock or insectivorous birds, but usually there is little interest and very little popular support for enforcement of this particular provision of law. State game commissions with inadequate staffs of patrol officers and many problems of protecting concentrations of valuable wildlife have more than they can do and they get little support from the public in enforcing these laws designed to protect species other than game.

THESE are only samples of the problems facing those who would do something to save our rare and vanishing forms. The prospects in some cases do not seem too good but there is nevertheless a determined effort to do some constructive work toward this end and more can undoubtedly be done, granted a greater public interest and support.

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¶ *Efforts that have been made to prevent wild ducks from following the heath hen and the passenger pigeon have already been so successful as to indicate the results that may be expected in other cases when conservationists and nature work toward a common goal. Faced with the fact that man and adverse breeding conditions were severely depleting the ranks of wild ducks, a concerted drive was made to find and apply remedies. To-day, with nature's help, ducks are present on their nesting and feeding grounds in constantly increasing numbers.*—The Editor.

OUR POINT OF VIEW

Sulfanilamide

THE regrettable death of some 70 persons, mostly in the South, as the result of taking a so-called elixir of sulfanilamide marketed by a drug house which has since denied legal responsibility but which cannot deny moral responsibility, has left a large part of the public confused and unable to assess the remaining status of the widely heralded drug sulfanilamide and its derivative drug prontosil. Naturally, there is now a widespread fear of this drug and its derivatives. What salient facts, then, are to be drawn from the available scientific data?

Anticipating the conclusions to be drawn below, these are that the elixir of sulfanilamide which caused the deaths was simply a slow poison; that sulfanilamide itself—not the elixifying material added to it that caused the deaths—will apparently continue to deserve the very considerable enthusiasm it has already aroused among doctors; but that it should not be sold indiscriminately to the general public for self-medication.

The many deaths that occurred were not in any sense caused by sulfanilamide. In order to put the sulfanilamide into potable solution the pharmaceutical house took on itself to add to it about 72 percent of a liquid, diethylene glycol. This, like many other substances, is poison if enough of it is taken, though not poison by another standard. "There is no evidence," the *Journal of the American Medical Association* states, "that its use in industry or as an ingredient of cigarettes is harmful. It is not to be taken in any considerable dosage internally." The now notorious elixir did, however, contain a considerable dosage. Ironically, the directions on the bottles of this medicament read, "Continue at this dosage until recovery."

Fortunately, every remaining drop of the elixir was finally traced down and seized by the government. Fortunately, also, no more is ever likely to be made up. Therefore, as far as assessing the value of sulfanilamide is concerned (after seeing to it, as we must, that the same ghastly thing does not happen again) we are where we stood before the tragedies. And so, in regard to the actual value of the drug, we quote from the noted journal named above: "Seldom has any new drug introduced in medical practice aroused the enthusiasm that has developed for sulfanilamide. Much of this enthusiasm is warranted. The drug is truly remarkable, as indicated by startling results reported in the treatment of various infections." There is, therefore, nothing to be gained and no doubt much to be lost in blackballing or blacklisting sulfanilamide at present. That should not be thought of.

However, the enthusiasm for the new drug should not be allowed to run entirely away with itself, for sulfanilamide is not perfect. In the *Journal of the American Medical Association*, as long ago as September 25, there were several articles by various physicians who pointed out certain toxic manifestations that can result from it in some cases. These were not sensational warnings—only ordinary ones. In other words, the drug is highly useful but must be handled with intelligence—specifically, more intelligence than was being used by the public even before the infamous elixir was put on the market.

Another conclusion reached by numerous doctors is that this drug ought not to be sold over the counters of drug stores to everyone, and ought not to be used indiscriminately by everyone in self-medication.

Behind and under all these considerations is the unfortunate fact that our existing federal drug laws are sadly inadequate to cope in advance with such situations as the one which recently arose. There was, and still is, nothing to prevent some other drug house from making a similar or worse blunder. The new Food and Drug Act, which was so sadly emasculated by a recent Congress and which has not yet been passed by Congress, should cover up such gaps in our ability to safeguard ourselves. However, when this bill comes up for further consideration, the many deaths that occurred will at least be a help in preserving some of its backbone.

In final analysis, the persons guilty of the recent deaths are the people of the United States. Here we are, the 125,000,000 of us, certainly our own masters, since nobody from without can dictate what we do, and obviously, it is to our interest not to poison ourselves. If we cannot will it that way and *make it come that way*, then whatever happens to us is our own fault. Let us dust off the spiked club.

Germ Warfare

RUMOR had it, during the World War, that the widespread epidemic of the fatal, so-called "Spanish" influenza was of German origin. The story was that the Germans had promoted this disastrous epidemic and, to prevent the world from knowing of their deed, had drawn a red herring across the trail by dubbing the disease Spanish. It was neither German nor Spanish; the rumor was simply propaganda.

Today there are many people who talk of bacterial warfare with as much credulity as those wartime rumor-mongers displayed. Or is it "gullibility"? Such an attitude among laymen is understandable. We should expect military men to spend no more time on the subject than that required to give one good hoot of derision. Recently, however, there was a discussion of germ warfare in the German military publication *Deutsche Wehr*, based on a report of an Italian medical officer. Apparently some Germans and Italians are studying its possibilities as a paralyzer of the enemy's morale.

The German article states that the most efficacious microbes would be those of spotted typhus, yellow fever, typhoid, paratyphoid, plague, cholera, and smallpox. The theory is that germs would be spread by dropping bombs or glass tubes containing them from airplanes over the enemy's hinterland and directed against civilians, for the use of this weapon "against soldiers would entail great dangers to the attacking troops."

Talk of germ warfare became so insistent during the World War that the League of Nations later set up a commission to study wholesale contagion and infection. The commission reported that a man-made epidemic would be "limited by our present knowledge of hygiene and microbiology" and, further, that "such epidemics would not have any decisive effect upon the issue of hostilities." So far as experts know, this holds as true today, and effectually answers the German article—until much more is learned of the subject!

Apparently study will continue. What the demonic breeders of ghastliness will have to do before success (awful death to their enemies!) rewards their efforts will be to discipline their germs. Regiments of them might then be turned toward the enemy and given the command "Charge!" Or perhaps obedient germs could be ordered to bite only the enemy. Otherwise, the scourge would inevitably backfire, no matter how far inland the germs are distributed. For unadulterated horror, bacterial warfare would certainly prove a most effective way of destroying foe and friend alike, but for war with some slight (*very* slight) semblance of humanity, explosives will still do a better job against the soldier enemy.

An air view of the New York metropolitan area, with Manhattan Island in the center, New Jersey and the Hudson River at the left, and the East River and Long Island at the right. The route of the three-part tunnel system is shown by white lines

In, Out, Through New York

Three-Part Tunnel System . . . New Jersey to Long Island . . . Under Hudson River, Manhattan, East River . . . Outstanding Engineering Features

By R. G. SKERRETT

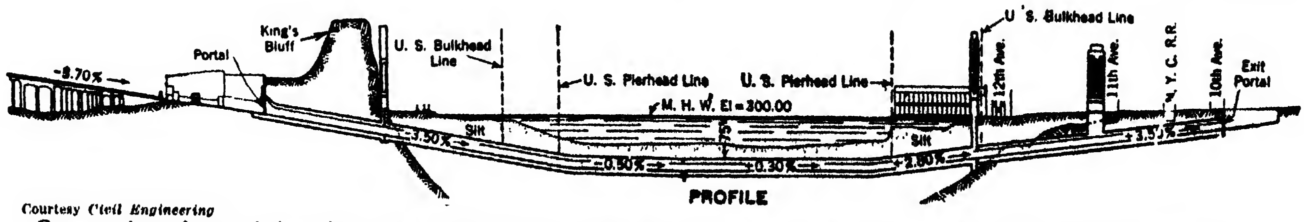
PICTURE an island 13 miles long and averaging about two miles in width, densely upbuilt, and with a resident population of 1,730,000 persons. Such, roughly, are some of the primary features of New York City, officially the Borough of Manhattan, and but a single subdivision of the City of Greater New York composed of five boroughs having a combined population of approximately 7,370,000 people.

To be a little more explicit: the Borough of Manhattan is the financial, commercial, industrial, shopping, and entertainment center of the more than 12,000,000 people who live within the so-called metropolitan zone—an area that embraces populous parts of northern New Jersey, western Connecticut, and the southeastern area of the state of New York. In and out of Manhattan there is a daily ebb and flow of 3,290,000 vehicles every 24 hours, traveling either above, on, or under the three rivers that make Manhattan an island. Over four of the East River bridges, this traffic tide has totaled more than 90,000,000 vehicles annually of late; between Manhattan and nearby New Jersey, the to-and-fro movement of vehicles has aggregated during the last year fully 31,500,000 crossings.

In Manhattan, traffic moves in cross-currents; streets are limited in their widths; the increment of motor vehicles is arbitrary and continuous; inevitably, thoroughfares become veritable bottlenecks for the passage of the crowding, multiplying pleasure cars, motor trucks, and motor buses. As the centers of concentration are approached, the vehicles cover shorter distances between the flashing of traffic signals, progress is correspondingly retarded, and vehicles designed for speed can make but little use of that inherent capacity. This restraint imposes on business, because of time lost, a daily penalty of something like half a million dollars.

To help solve the vehicular problem of the metropolitan zone, so far as its focal center in the Borough of Manhattan is concerned, the states of New York and New Jersey, through the Port of New York Authority—a bi-state organization—financed and built the Holland Tunnel under the Hudson and the George Washington Bridge over the same river. These two facilities permit a continuous flow of traffic across the Hudson far downtown and far uptown, a condition previously impossible with ferries.

In the past year, the Holland Tunnel and the George Washington Bridge have afforded quick runs for 60 percent of the vehicles crossing the Hudson, leaving the remainder to be transported by ferries. It is a curious fact, familiar to traffic



Courtesy *Civil Engineering*

Cross-section of one of the tubes under the Hudson, one of which is now practically completed. This drawing gives some of the main dimensions and shows the structural features. The New Jersey shore line is at the left, Manhattan at the right

experts, that each added permanent crossing, besides providing relief, actually attracts traffic which did not exist previously. Experience has shown that the owners of motor vehicles will willingly pay a premium to use a shorter, faster, and more convenient route; as between a free route and a toll route, the public does not hesitate to pay if time or distance may be saved. This attitude helps to explain why traffic through the Holland Tunnel in 1928, the first full calendar year after those tubes were placed in service, totaled 8,744,674 revenue vehicles, and 11,877,304 in 1936. The George Washington Bridge, in 1932—it was placed in service late in 1931—was crossed by 5,509,946 revenue vehicles and by 7,057,384 in 1936.

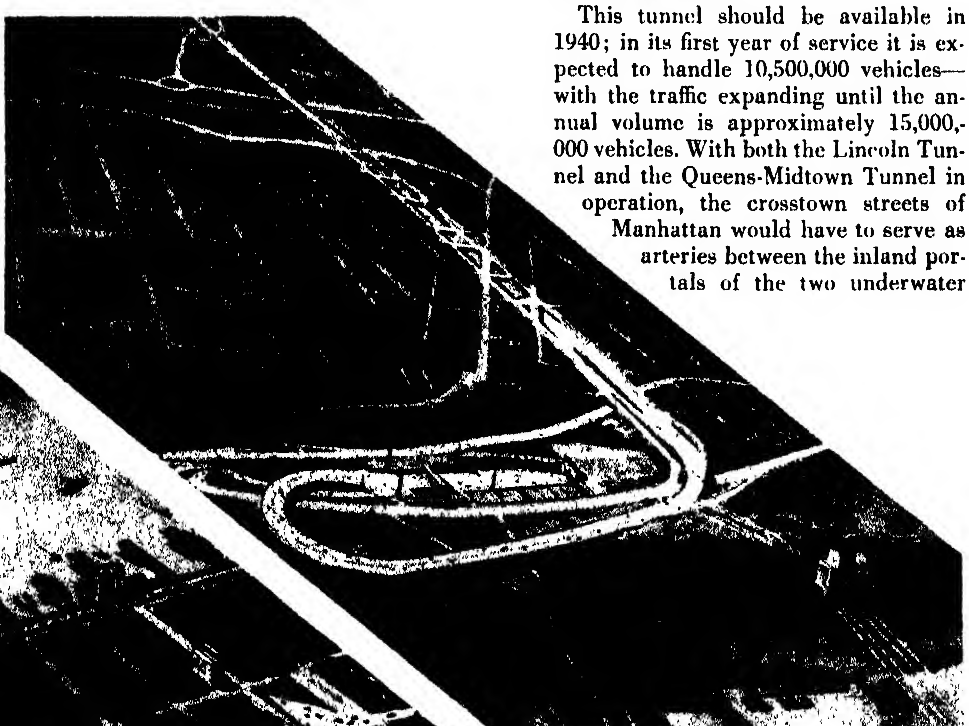
The Holland Tunnel links the lower part of the Island of Manhattan with Jersey City; between that subaqueous crossing and the George Washington Bridge is an interval of 10 miles. The center of gravity of motor traffic and the most congested areas of New York City lie approximately midway between these crossings. Therefore, trans-Hudson motor traffic has either to use the ferries or to travel long distances north and south to avail itself of the George Washington Bridge or the Holland Tunnel. In that north-and-south movement to utilize the permanent crossings, motor vehicles in Manhattan unavoidably add to street congestion and intensify traffic-regulating difficulties.

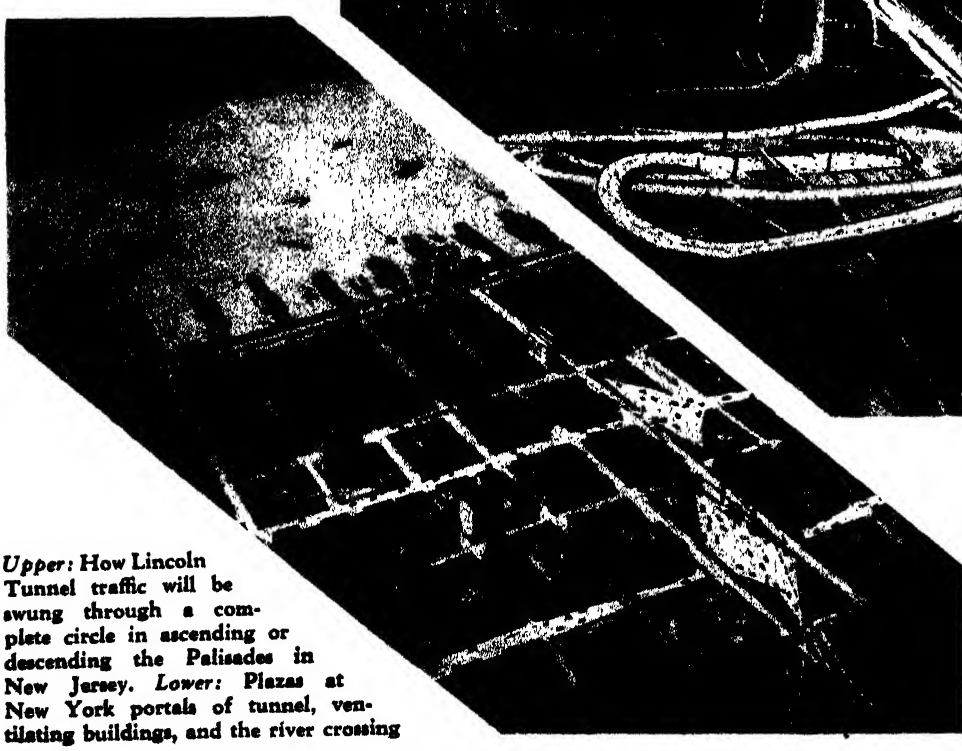
It was thus obvious to the Port of New York Authority that the midtown area of Manhattan should be linked with New Jersey by a second twin-tube vehicular tunnel, inasmuch as the Holland Tunnel by 1931 was operating normally at 80 percent of its capacity, and on holidays and other peak periods the twin tubes were overtaxed and imposed delays. Because of the depression, funds for building the Lincoln Tunnel, from West 39th Street in Manhattan to Weehawken, New Jersey, were not available until the latter part of 1933. Actual construction started in March of the year following, and was concentrated in driving and completing but one of the two tubes that will form the Lincoln Tunnel, which is located three miles north of the Holland Tunnel.

BY building one tube first and making that ready for service in December of 1937, the initial financial outlays were reduced accordingly, and one tube would thus be ready for traffic and earning money while the second tube was in process of construction. One tube will provide for a single traffic lane in each direction, and in the course of a year should facilitate the passage of from 5,000,000 to 6,000,000 vehicles. When the second tube is finished in 1940—work on it is now under way—both lanes of one tube will be used by westbound traffic, and the two lanes of the other tube by eastbound traffic. The two tubes annually will handle traffic totaling 10,000,000 and more vehicles. The Lincoln Tunnel, when completed, will have entailed a total outlay of 74,800,000 dollars.

Because the tunnel will induce additional traffic, the municipal authorities recognized that a vehicular tunnel under the East River, on the opposite side of the island, should be built to accelerate through traffic between New Jersey and Long Island as well as interborough traffic between New York City and the sister boroughs of populous Queens and Brooklyn—within the limits of which there are resident more than 4,000,000 people. The New York City Tunnel Authority was created to design and to construct what is officially known as the Queens-Midtown Tunnel. This will cross the East River between 42nd Street, Manhattan, and Borden Avenue, on the water front of Queens, and will be near existing highways that connect with the northern limits of the adjacent Borough of Brooklyn. Work is proceeding on this tunnel; under-river driving of the twin-tube shields will start in January, 1938. It will probably cost, when completed, 58,365,000 dollars.

This tunnel should be available in 1940; in its first year of service it is expected to handle 10,500,000 vehicles—with the traffic expanding until the annual volume is approximately 15,000,000 vehicles. With both the Lincoln Tunnel and the Queens-Midtown Tunnel in operation, the crosstown streets of Manhattan would have to serve as arteries between the inland portals of the two underwater routes. This increased volume of traffic to and fro on the streets would inevitably make for confusion and delays. Therefore, the Borough of Manhattan has been authorized by the Legislature of New York State to construct, deep in the rocky body of the island, twin connecting tunnels that will provide under-





Upper: **How Lincoln Tunnel traffic will be swung through a complete circle in ascending or descending the Palisades in New Jersey.** ***Lower:*** **Plazas at New York portals of tunnel, ventilating buildings, and the river crossing**

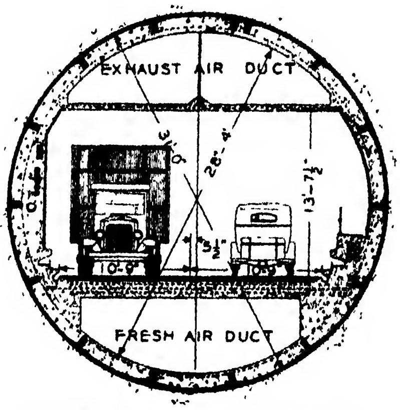
ground arteries for much of the traffic entering and leaving Manhattan via the two new tunnels, and be the preferred route for vehicles intent upon making the best speed possible between the New Jersey (western) side of the Hudson River and the Long Island (eastern) side of the East River. Its cost is estimated at 30,000,000 dollars. If funds are made available shortly, that vitally essential link can be excavated and made ready for service also in 1940.

The unified project of two subaqueous tunnels and an interconnecting land tunnel calls for a total outlay of 163,165,000 dollars. This tremendous sum will be well spent if it achieves the expected traffic relief prophesied by the experts.

The projected tripartite route will have a total length between New Jersey and Long Island of about 4.75 miles; and it will be entirely feasible for through-bound vehicles to maintain a speed of 30 miles an hour in making that run. Today, on one of the most used East River bridges, especially during busy hours and peak periods, delays occur ranging from a few minutes to half an hour; when that traffic is bound westward to the Hudson River side of Manhattan, the loss in time is apt to be increased when intercepting north-and-south traffic is heavy. The three interlinked tunnels beneath the two rivers and through Manhattan will change all this for the better. The consequent economies and the revenue through reasonable tolls should pay handsomely for the initial expenditures.

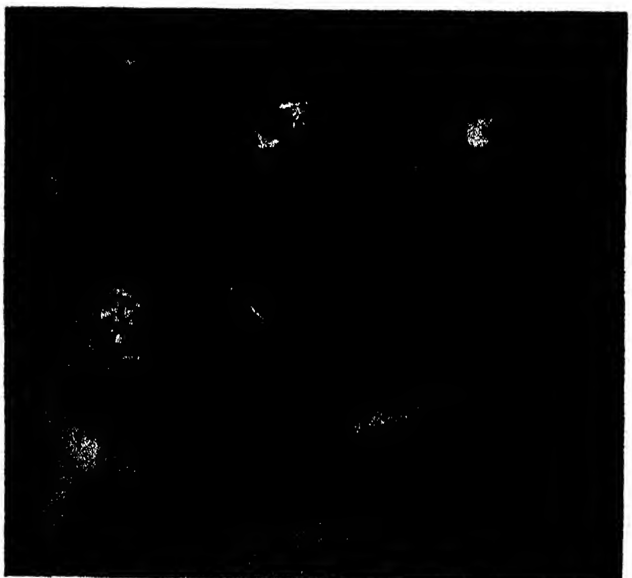
THE first or south tube of the Lincoln Tunnel, which was recently put into use, has a length of 8215 feet between its east and west portals. The north tube, which generally parallels the south tube, will have a length between portals of 7400 feet. Both tubes, however, have an under-river length of 4600 feet; the difference in over-all lengths is because the Manhattan portal of one tube is nearer the water front than the other. The New York portals are connected with sunken, flaring approaches which are reached by new sloping streets that adjoin the approaches at right angles and rise so as to provide easy access to the regular thoroughfares of neighboring sections of the town. Vehicles can approach or leave these portals without disrupting local traffic.

On the west side of the Hudson, the line of the tunnel is abruptly confronted by the rocky Palisades that rise to a maximum elevation of nearly 200 feet above the surface of the river. The town of Weehawken, at the foot of and on the east shoulder of the Palisades, demanded access to the Lincoln Tunnel; similarly, communities along the crest of the Palisades insisted that they be able to get easily to and from the tunnel; finally, other places on the western side of the Palisades, north and south, were equally urgent that connections be provided for



Typical section, with dimensions, of one of the Lincoln Tunnel tubes

them. Therefore, instead of driving the tunnel due west right through the Palisades, which would have cost less but would have side-stepped some of these New Jersey communities, the tunnel makes a 90-degree swing southward on reaching the New Jersey side of the river, pierces a towering tongue of rock, and issues into the open in a low area at the foot of the Palisades. Within that area is an expansive "mixing basin" for tunnel traffic. Between that basin and a sunken highway, up and over the Palisades, there is a steel-and-concrete inclined loop of ingenious design that swings the vehicular streams through an arc of 270 degrees and makes an easy change of grade either in starting traffic upward over the Palisades or downward into the plaza outside the west portals. The sunken road over the Palisades, cut 20 feet deep in rock, is paralleled by two surface roadways which connect with important thoroughfares and afford access to the sunken approach artery. The feeder system takes care of Weehawken and connects with numerous important trunk highways. From end to end, the new route over the Palisades has a length of nearly two miles, and the maximum grade does not exceed 4 percent. This approach system will cost about 10,000,000 dollars.



A tough, doughy slab of muck squeezing through an opening in a shield, like tooth-paste from a tube

TWO shields were used to drive the south tube. The New York shield worked its way westward from an inland shaft a distance of 910 feet through solid rock, rock and earth, and water-bearing ground, successively, to reach the foundation caisson of the ventilating structure at the Manhattan water front. The New Jersey shield started eastward from the bottom of the Weehawken ventilating shaft, and worked its way under the river to the Manhattan caisson, a total journey of 5050 feet. For 4600 feet, the shield made its way through the silt of the river bed, admitting 20 percent of the displaced material into the lengthening tunnel as the shield forced itself forward; the remaining 80 percent was shoved mainly sidewise and upward along the lines of least resistance. The intaken silt was distributed in the lower half of the tube to give the tube sufficient deadweight to neutralize its buoyancy, to avoid using the air locks at the shoreward end to transport the muck to the surface, and, finally, to steady the tube and provide a firmer footing for the shield when power was applied for a forward shove. This muck was left undisturbed until the tube reached from shore to shore and the tunnel was no longer charged with compressed air, as was required during driving. Indeed, because of the procedure adopted, the sandhogs worked generally at a much lower air pressure than the depth underwater would ordinarily have necessitated.

The two shields used were virtually identical in dimensions and basic features. Their cylindrical steel shells have an external diameter of 31.7 feet, an over-all length of 19 feet, a cutting edge of cast steel at the forward end, and, near the rear end, each has 28 powerful hydraulic jacks, arranged circumferentially, that can push rearward against the last assembled ring of the lining to shove the shield forward 30 inches to provide space for the insertion and assembling of the segments of still another ring.

The silt admitted to the tunnel entered through two openings in the great circular bulkhead at the forward end of the shield.

As the thick ribbons of muck came inward, men sliced them with wires into blocks that were dropped on belt conveyors which, in turn, distributed the chunks on the tunnel floor, from side to side. Each shield carried, pivoted at its longitudinal axis, a rotating erector that could pick up, one by one, segments of the lining and place them in their proper order to form a unit ring. A special grip at the end of the working arm made for operating speed. To hasten the bolting of the segments to one another and to the adjoining completed ring, the contractor developed unique hydropneumatic tighteners to avoid much slower handwork. Four of these powerful machines were mounted at the forward end of a large trailer that could be attached and pulled along by the shield. Each tightener worked within its given arc, so that there was no confusion as each one of them was brought into action. The tighteners contributed very largely to the rapid progress made in driving the tunnel under the river.

Each of the under-river cast-iron or cast-steel lining rings has an external diameter of 31 feet; in place and bolted, a ring weighs about 21.5 tons. A ring is made up of 14 identical segments and a key member; 145 bolts, each with a large nut and two washers, are required to secure a ring circumferentially and longitudinally. A lining ring was inserted for every 2.5 linear feet of the tunnel shell. Every bolt had to be made tight so that the tunnel lining would be a rigid structure and sealed against leakage. The top of the tunnel lies 75 feet below mean high water.

IN driving the older Holland Tunnel, the maximum linear advance through the bed of the river was 25 feet in 24 hours. In driving the south tube of the Lincoln Tunnel, through the same silt, as many as 18 shoves were made in 24 hours and 45.5 feet of tunnel lining was placed. The under-river shield started on its eastward trip September 29, 1934, and on August 17, 1935, it passed through the west "eye" of the New York caisson, and came to rest with an ultimate precision of line that was only ¼ of an inch out from grade and with but ⅜ inch of departure laterally. Like a titanic mole, the shield advanced unseeing through the river bed following a descending course to midstream and then mounted again by an easy grade until it reached the caisson. The companion tube will be 75 feet to the north, between centers.

Roadways in each tube will be 21.5 feet wide—18 inches wider than the roadways of the Holland Tunnel. The two broader traffic lanes in each tube will increase the margin of safety and make it easier for vehicles to swing out of line in getting past a stalled car. The ceiling of the finished tube is surfaced with glass tiles set in special bronze grips which, in turn, are anchored to the concrete ceiling slabs which form the underside of the ventilating duct through which vitiated air is withdrawn from the tunnel. The fresh-air duct is beneath the roadway with discharge ducts at the sides of the tunnel just above the roadway. The sidewalls are covered with glazed tiles, and the curb on one side and the outer face of the patrolmen's sidewalk on the other side are of glazed terra-cotta. This use of glass and glazed tiles will make it easy to clean the exposed surfaces. The glass in the ceiling is cream colored and has a pebbled surface capable of diffusing a very high percentage of reflected light without glare.

The suction fans and the fresh-air blowers of the ventilation system are being placed in three buildings: one at the east base of the Palisades, in Weehawken, and two on the New York side of the river. The New Jersey plant will ventilate the tunnel between the west portals and mid-river; the two New York plants will provide proper ventilation between mid-river and the Manhattan portals. For the two tubes there will be a total of 26 fresh-air blowers and 30 exhaust fans, and there will be reserve units available even when the ventilating plants are operating at their designed maximum capacities. Electric apparatus, placed at intervals along the tubes, will detect and record any vitiation of the atmosphere and thus indicate the number of ventilating units necessary at all times. The tunnel is being equipped with the most approved traffic signaling system and is to be generally illuminated with sodium-vapor lamps that will increase visibility.

Illustrations, except one noted, courtesy Port of New York Authority

Erector on the shield that drove the south tube under the Hudson. It can be swung through a circle to place steel ring segments anywhere in the tube-lining ring

We cannot now deal in detail with the Queens-Midtown Tunnel, but we can say that it will be more difficult to drive because of the mixed formations of rock, sand, gravel, and silt in the bed of the East River. Nor can we give at this time particulars about the Midtown-Manhattan Tunnel, which will require the driving of capacious twin tunnels through solid rock at a maximum depth of 100 feet below the street surface in order to under-run existing and projected rapid-transit subways. These will be discussed later. Each will be important in its own right and each will necessitate employment of unique engineering methods by reason of the unusual problems that will be encountered. As has been shown, however, each will also be a vital part of the whole—a unified system which, while costly, will solve a traffic problem of the first magnitude. Furthermore, they will doubtless give to New York engineering experience which will influence decisions regarding such tunnels in the future, wherever they may be constructed.

WHAT is being done in the Port of New York and within the metropolis is an object lesson as a whole of the tremendous outlays being forced upon populous centers to ease the growing tide of motor vehicles into them, through them, and out of them so that these conveyances can make more effective use of the driving power with which they are equipped. Each and all of us, directly or indirectly, are paying for loss of time resulting from traffic congestion and its consequent delays. The bill daily or annually is an enormous one.

Ra-mose and Hat-nufer*

By AMBROSE LANSING
Associate Curator of the Department of Egyptian Art of the Metropolitan Museum of Art; In Charge, Metropolitan Museum Excavations in Egypt

and WILLIAM C. HAYES
Assistant Curator of the Department of Egyptian Art of the Metropolitan Museum of Art

(In Three Parts—Part Three)

OUR first efforts to open the Canopic chest were checked by a locking device similar to that already encountered on Hat-nufer's coffin. In the chest the binding elements were not tenons but tongues projecting laterally from the ends of the transverse cleats on the underside of the lid, which fitted into L-shaped mortises on the inner surfaces of the sides of the box (Figure

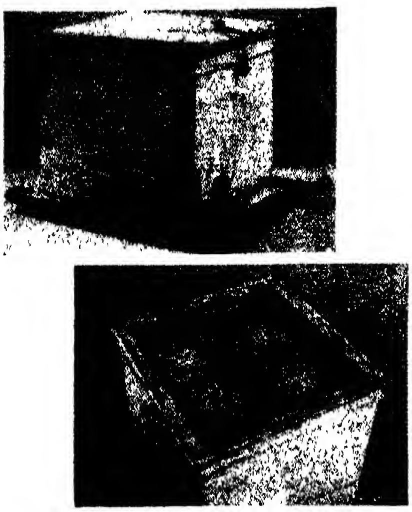


Figure 15: **The Canopic chest. Inside were the Canopic vases for the entrails, as per the Egyptian custom**

15). As with the coffin, there are vertical guiding tenons in the sides of the lid and, of course, the essential tumbler near its front edge, which in this case had dropped down behind the front edge of the box when the lid was slid shut. The removal of what proved to be the outer lid of the chest revealed an inner lid. These two "doors" rested on the two crossed partitions which divide the interior of the chest into four compartments, and were locked down by a boxwood bolt passed through wooden staples at the centers of their contiguous inner edges. The bolt was fitted with a small ebony tumbler which was intended to fall between the first and second staples when the bolt was shot home, thus making its removal impossible. Fortunately for us, however, the tumbler had failed to function, so that the bolt was easily withdrawn and the interior of the chest at last revealed.

Its contents constituted a distinct anticlimax. The four Canopic jars and their stoppers are of pottery. The jars are uninscribed, and both they and the stoppers vary considerably in size and proportions. Three of the stoppers are in the form of human heads, as was usual at this time, but the head of the fourth stopper is that of a canine animal (the Genius Dua-maut-ef), with long snout and upstanding ears. As if to give it further prominence, this stopper is whitewashed. The jars, packed in sawdust, natron, and linen wadding, occupied the four compartments in the interior of the chest. One of the wads, when unfolded, proved to be a shirt, similar to those found on the bodies of Ra-mose and Hat-nufer, of fine linen, very pale in color, but with vertical stripes of dark brown running through it. Each jar contained one of the human organs.

The three linen chests were opened next. Of these, two (*E* and *F*, see Figure 16) are plain, rectangular boxes with flat lids, made of heavy and somewhat rough sycamore boards. The third (*J*) is not only more elaborate in form but is

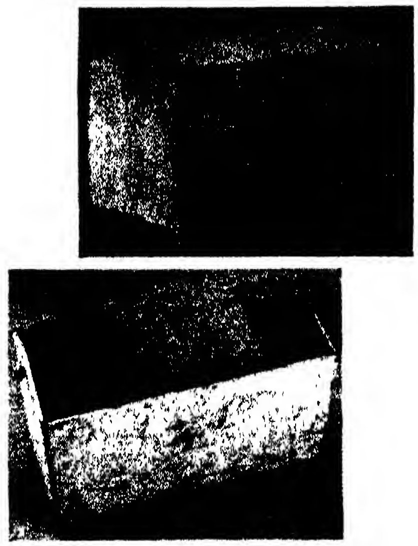


Figure 17: **Chest *J*, of whitewashed pine, and filled with linen sheets**

of better material (pine) and is more carefully constructed and finished. It has a gable lid and stands on four short legs (Figure 17). All three chests are whitewashed inside and out. Each chest was equipped with two stout knobs, one on the end of the lid, one on the corresponding end of the box; and by means of these the lid had been lashed in place

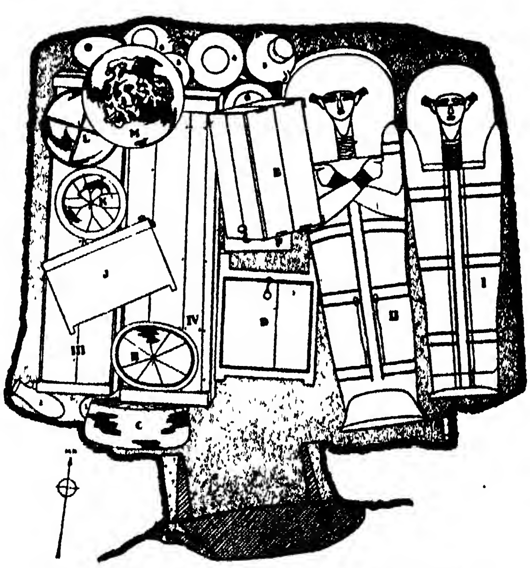


Figure 16: **Plan of the tomb, with numbers and letters mentioned throughout the text**

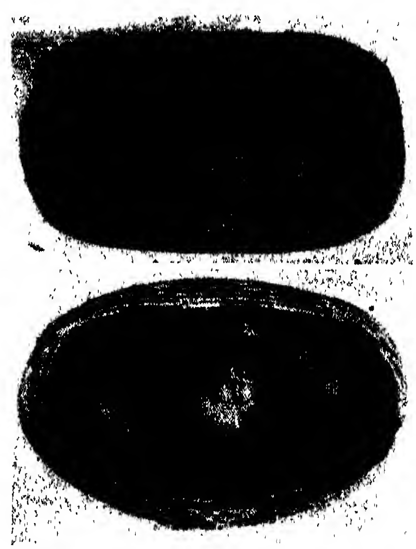


Figure 18: **Basket *C*, with bread and fruits that were very dry but intact**

*Courtesy the *Bulletin* of the Metropolitan Museum of Art.

with cord, the knotting of the cord between the knobs being secured by a stamped mud sealing. Chests *E* and *J* were fairly clean and fresh, but chest *F* had evidently been in use for a long time before its introduction into the tomb. A hieratic inventory written on the underside of its lid shows, indeed, that it had at one time contained a quantity of metal tools, vessels, and other objects. Under this list were the partially erased remains of an earlier but similar one, at the beginning of which are preserved the name and title of Sen-Mut's brother, the "*web*-priest of Amun, Minhotpe."

The chests contained, between them, seventy-six long, fringed sheets, or "bolts," of linen cloth, each sheet folded to form a neat rectangular bundle. The cloth differs in spin and weave, so that the sheets vary in texture from a very coarse material like burlap to a remarkably fine, filmy, weblike cambric and in color from dark brown to almost pure white. Each sheet is woven in one piece, in lengths ranging from 4.5 to 16.5 meters. In addition to weavers' marks worked in the fabric, 29 of the sheets bear identification marks in black ink. Nearly all the latter are marks of the

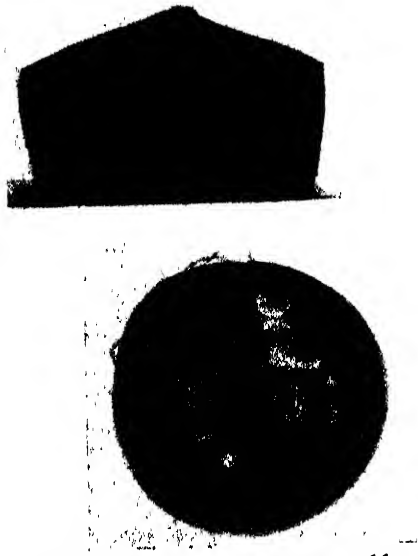


Figure 19: Basket L and its odd batch of small personal belongings

government and temple linen store whence, we may assume, Hat-nufer drew or purchased the cloth. The only private name which occurs among these marks is that of an individual named Boki. There is not much doubt that the sheets—clean and neatly pressed—represent not embalmers' equipment but Hat-nufer's supply of household linen. Their amazing state of preservation allowed them to be unfolded, measured, and refolded at will.

Four of the five baskets, or hampers (*C, K, L, O*), and the basketry tray (*M*) are made of halfa grass by the common sewn-coil technique, and are decorated with geometric designs in black and

Figure 20: A silver wine service. Their size is shown by Figure 19

red. Their bottoms, inner rims, and other parts which were required to stand special wear or strain are whipped with palm-leaf strip. Basket *H*, the only undecorated example, is entirely of palm leaf. All are outstanding examples of a craft which has survived in northern and central Africa from the most ancient times to the present day with little change in technique or decoration.

By untying a single knot at the center of the lid of each basket we were able to release the series of cord loops by means of which the basket had been securely sealed for 34 centuries. The contents of the baskets varied a good deal in type and interest. Basket *C* was packed with loaves of bread, dates, and raisins disposed in three small pottery dishes, and lumps of black matter, also containing raisins, which look as wedding cake might if kept for 3000 years (Figure 18). The bread is of two kinds, one light brown with a hard, glossy crust like that of modern Vienna rolls, the other dark, grayish brown, with a rough surface. Of the four types of loaf the most interesting is a long, flat form of fancy shape, possibly intended to suggest a human figure.

BASKET *H*, the most carefully sealed of the lot, contained nothing but a jumbled mass of dirty, oil-soaked bandages, probably used in the process of embalming Hat-nufer's mummy. The entire contents of basket *K* consisted of five linen sheets, clean, pressed, folded into bundles, and altogether similar to those from the boxes. When the removal of the lid of basket *L* (Figure 19) revealed another such sheet, we began to become a trifle discouraged with the baskets and their contents. But below this sheet, which turned out to be the biggest found in the tomb—more than 50 feet in length—lay a group of objects of considerably greater interest. Foremost among them was a set of three small vessels of beaten silver (Figure 20), consisting of a hemispherical bowl with a low stand soldered to its underside and a pair of little pitchers—one, as usual, slightly larger than the other—with handles of silver wire. The lower end of the handle, where it is attached to the side of the pitcher, is, in each case, in the form of a lily, or sedge, plant, one of the emblems of Upper Egypt. With the silver vessels was a bronze razor (Figure 21), equipped with a nicely carved boxwood handle and carefully wrapped in narrow linen bandages. In the silver bowl lay a necklace of faience lenticular beads, and near by, two little unguent jars of pottery, their mouths covered with pieces of linen cloth.

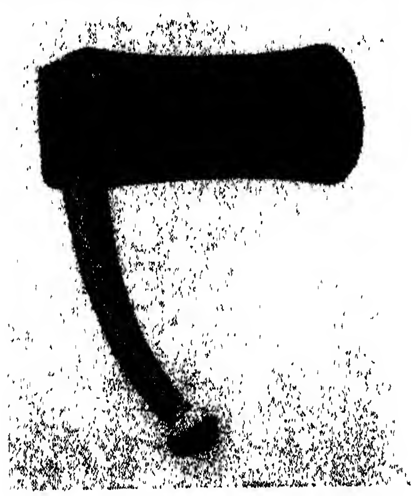


Figure 21: Hat-nufer's razor is still almost sharp enough to shave with

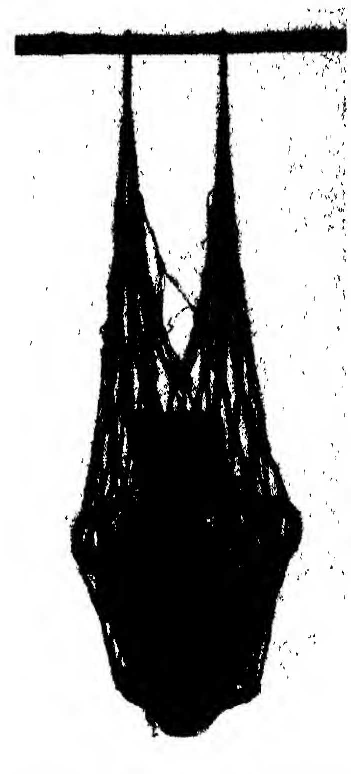


Figure 22: A net sling used for carrying the large jar within it

Lying bunched together in the basketry tray *M*, were a net sling of linen cord and a tufted linen square, perhaps a chair pad, or possibly a donkey saddle. The pot sling is an unusually good example of its type and is of all the more value because of its perfect state of preservation. The net was undoubtedly used to transport the larger pottery vessels into the tomb, and in Figure 22, it is illustrated in position around one of the three amphorae.

The lid of basket *O* had been removed in antiquity, apparently after the basket

had been brought into the tomb, and very carelessly replaced; and of the original contents of the basket only a few objects were found, lying in loose disarray at the bottom: a lidless alabaster jar, a small serpentine kohl jar, also minus its lid, an ebony kohl stick, and a small, colored grass basket. The lid of the basket had also been pulled off and the basket was empty except for one blue faience lenticular bead—apparently one of the many beads which we may assume the basket once contained.

A brief survey of the objects from Hat-nufer's coffin and from her boxes and baskets immediately disclosed the fact that the group, while impressive, was not complete. There were still missing from it several of the more important items which we had come to associate as a matter of course with the burials of well-to-do ladies of the early and middle

Figure 23: **Hat-nufer's hand mirror is of polished bronze**

XVIII Dynasty. These include full-sized mirrors, a large kohl jar, a toilet box or dish, and the very common decorated faience bowls for flowers. It was not until later that we found the missing objects cached in the foot end of one of the cheap rectangular coffins, to the miserable occupants of which they clearly did not belong. Perhaps their presence there was due to some exigency which cropped up at the time the tomb was being sealed, or even to an attempt at pilfering by one of the undertakers, which threatened to be discovered before he could remove his loot from the tomb. In regard to the latter supposition it should be recalled that basket *O*, from which the objects could have come, had been roughly pulled open and was found more than two thirds empty. However that may be, the group of articles from the foot end of the rectangular coffin is of a quality consistent with the rest of Hat-nufer's possessions and includes just the items which we had noted as lacking from these. There are two mirrors, both of bronze, the larger with a wooden handle in the form of a papyrus stalk and umbel, the smaller entirely of metal, with a similar handle, in this case ornamented on each side with a relief head of the goddess Hat-Hor (Figure 23); a circular wooden toilet dish with a swivel lid, decorated with an incised design of concentric and contiguous circles (Figure 24); a pair of wooden castanets carved in the form of elongated human hands; a large alabaster kohl jar and lid, the lip of the jar broken away and missing;

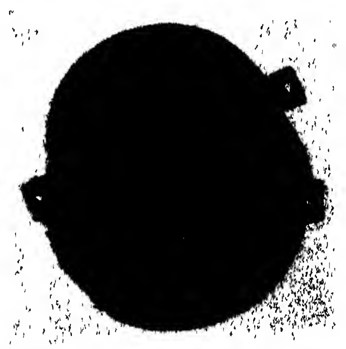


Figure 24: **A circular wooden toilet dish having an incised design**

a bowl of deep blue faience, decorated with a lotus-flower design in black outline (see Figure 25); two blue faience saucers with black decoration (Figure 25), one with the title and prenomen of Thut-mose II; and seven scaraboid beads of glossy blue faience, two of them also inscribed with the prenomen of Thut-mose II.

The two large alabaster jars (shown in Figure 26) from the floor of the chamber by the north end of coffin IV are well-known XVIII Dynasty types. Both are distinguished by their fine surface polish and the beauty of the ornately grained, translucent alabaster of which they are made. Their tops were covered by pieces of linen cloth, lashed about their necks with cord, the knots secured by stamped mud seals. One jar is uninscribed, but engraved on the side of the other is a short column of hieroglyphic inscription giving the personal name of Hat-shepsut

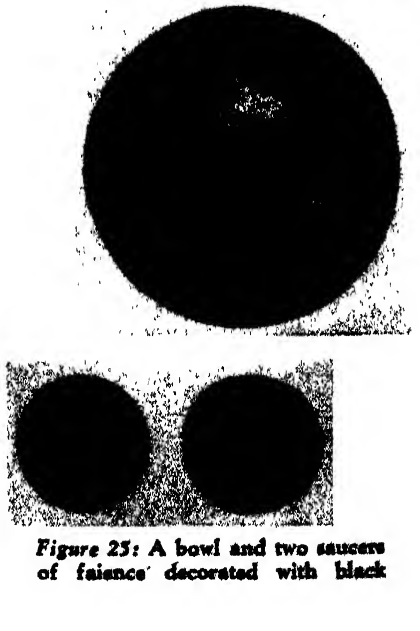


Figure 25: **A bowl and two saucers of faience decorated with black**

(for whom the jar may have been originally made), accompanied by her early titles as Queen of Egypt. The latter jar has not been opened, but the other was nearly filled with a thick resinous gum, which, amazing as it may seem, was still soft at the time the jar was opened by us.

The three great pottery amphorae (3, 4, 6, Figure 16), found stacked along the north wall of the chamber, are of interest mainly for the oval stamp impressions on their heavy mud sealings and the ink labels which they bear on their sides. Nine of the stamp impressions bear the name and title of Hat-shepsut as queen, but on four others are her title and prenomen as king. The labels give the names of the various wood oils contained in the jars. The label on amphora 4 is preceded by the date "Regnal Year 7" (of Thut-mose III). The squat, long-necked pottery jar No. 5, equipped with two inverted-U handles, also bears the year date 7, accompanied by designations of the month and day and followed by a description of the contents of the jar. These dated ink inscriptions form an excellent index of date for the tomb, which, we now know, was sealed late in the seventh year of the reign of Thut-mose III (1494 B.C.).

WE are fortunate in this tomb in having not only the names of the oils contained in the jars but also copious specimens of the oils themselves, which can be analyzed chemically and so give us more exact meanings of the names than have hitherto been known.

Other pottery vessels, found on the

Figure 26: **The gum found in one of these jars had never hardened**

floor of the chamber by the south end of coffin III, include a long, drop-shaped jar (2), decorated with a red slip and bands of black, and two small pottery dishes in soft brown ware.

These completed the possessions of Hat-nufer.

(The End)

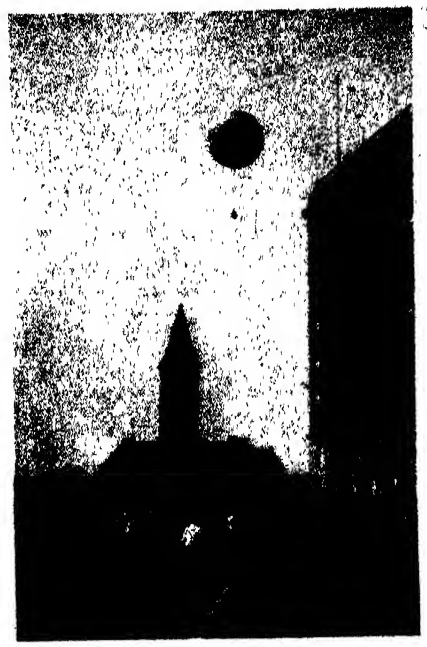
●

***BOTH industry and business are now seeking from science an explanation of the long-period swings in business activity, which must have some cause. In a coming article this subject will be discussed. Its author refers to the effect of climate and weather as a "dictatorship over man, a fact which is being increasingly realized."*—Editor.**

Photographing Traffic from the Air

THE captive balloon, long familiar as a war-time device for keeping watch over enemy activities from the air, has been given an important peace-time job—that of surveying city traffic. In this new use, it promises to become a valuable weapon in the war upon accidents, for it will enable traffic engineers to study at their leisure actual driving conditions at key locations and draw conclusions as to safety measures that should be put into practice or changes in traffic regulations that should be made.

As a traffic surveyor, the captive balloon is not as large as its war-time ancestor, nor does it carry an observer. Instead, it is only 12 feet in diameter and carries a camera which is operated by remote control from the ground. Until recently, it had been used only at a number of typical intersections in Milwaukee and Milwaukee County, according to its inventor, Carl V. Bergstrom, a Traffic Engineer in the Bureau of Electrical Service, of Milwaukee, who discussed its use in *Public Safety.*



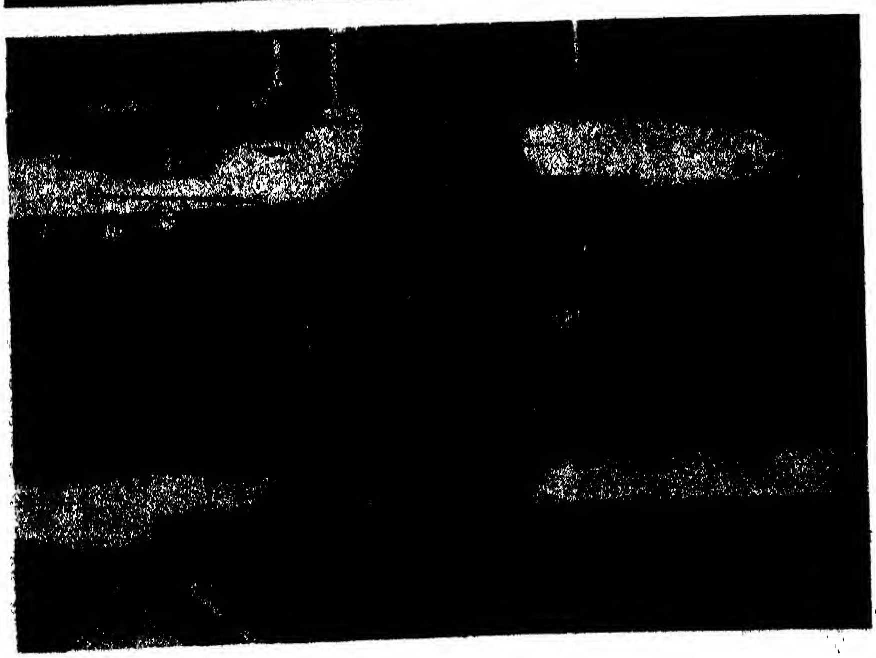
Above: **Aerial camera and balloon in operation; guy ropes held by nearest man and one just visible in distance.** ***Milwaukee Journal*** **photo**

Left: **While the inventor, Carl V. Bergstrom, stands on a ledge, his picture is taken from below to show camera.** ***Milwaukee Journal*** **photo**

Left: **One man steadies the balloon while two make necessary adjustments to the camera before an ascension**

Right: **The car and trailer which carry the inflated balloon, camera, and all needed auxiliary equipment**

Below: **A picture tells more than a draftsman's sketch and is much cheaper to make. A Milwaukee corner**

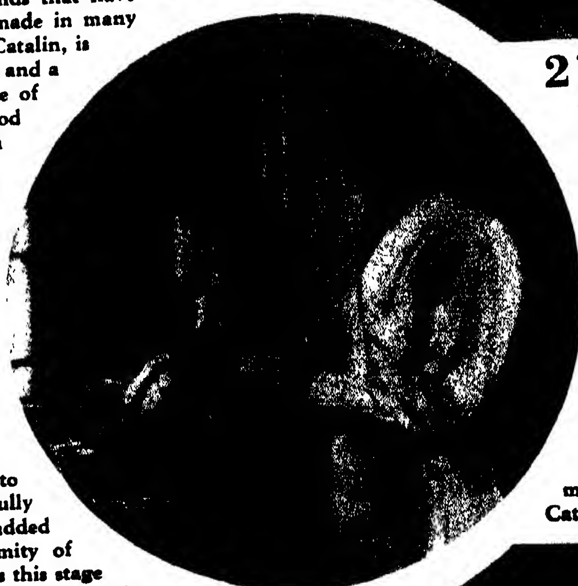


The camera, which is a view model making a five by seven inch picture, and the balloon and necessary guy and control cables, are transported by means of a passenger automobile and small trailer. The balloon is guyed to the trailer in such a way that a speed of 20 miles an hour can be made. On arriving at an intersection to be photographed, the camera is fastened to the lower end of a pendulum assembly which, in turn, is attached to the bridle of the balloon by means of a universal joint, and the balloon is permitted to rise, control being maintained by guy ropes. It is maneuvered until it is directly over the center of the intersection and then the plate is exposed. Batteries and a push button operate the shutter.

A Plastic

Plastics, those colorful synthetic compounds that have
· invaded so many fields of industry, are made in many
ıys, from many ingredients. One of them, Catalin, is
ıemically born of a mixture of a clear liquid and a
ıs captivated in water—phenol, a derivative of
ıal, and formaldehyde, a derivative of wood
cohol, which, in turn, is derived from such
ıurces as wood pulp, cornstalks, even hay

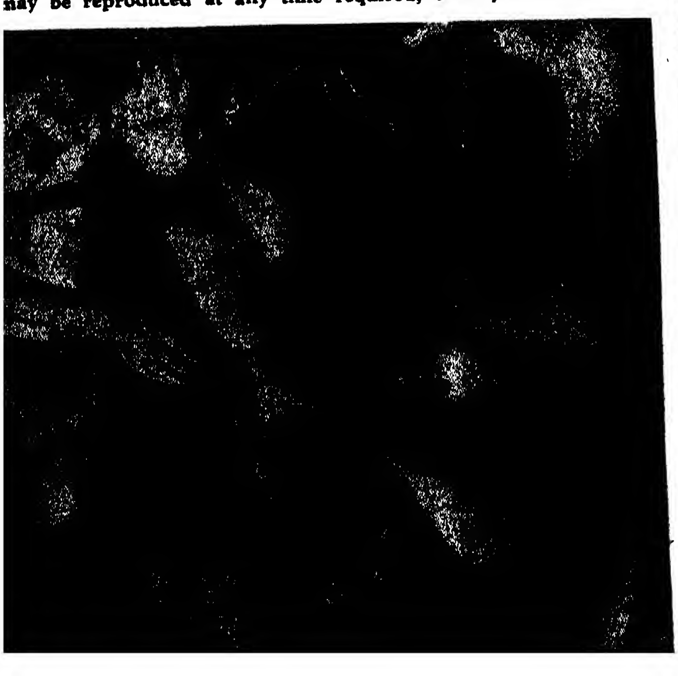
2 The liquids (see photograph No. 1) are mixed in this battery of nickel-lined kettles where the compound is cooked at low temperature until it reaches the consistency and color of honey. The kettles, only the tops of which are shown, each hold 3000 pounds of liquid resin

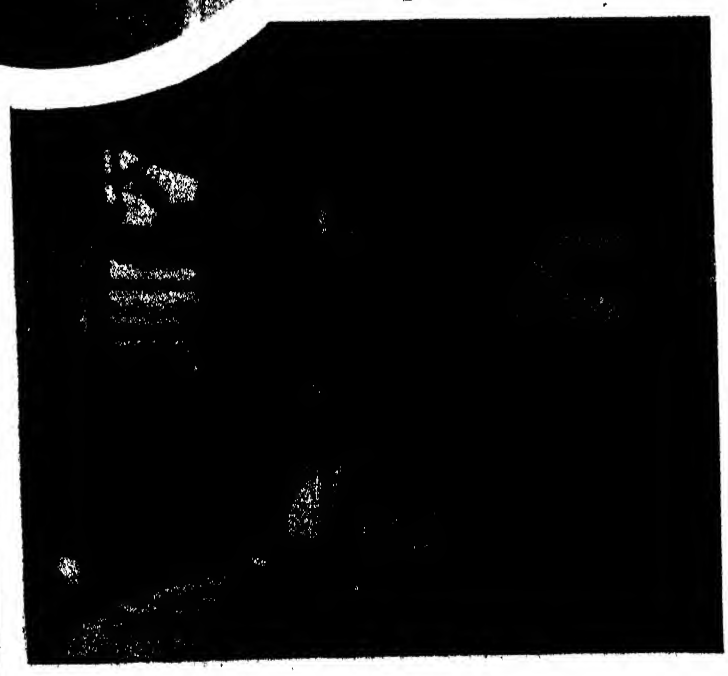


3 While the mixture is cooking, the color chemist prepares the required batch
f coloring material of the desired shade.
y proper control at this point, the fin-
ıhed plastic may be produced in colors
ınging from water-white, resembling
lass, to pastels, vivid hues, black, or white

4 *Below:* Just before the cooked mixture is to be drawn off from the kettles, a carefully
neasured amount of coloring material is added
ınd thoroughly agitated to assure uniformity of
:olor throughout the material. So accurate is this stage
ɔf the production that the exact shade of a certain color
nay be reproduced at any time required, even years later

5 *Below:* The cooked and colored plastic is drawn off from the bottom of the kettle into ladles, from which it is transferred to lead molds where it is formed into rods, cylinders, and other regular or irregular shapes. The pour must be made in small batches, as the cooked Catalin begins to harden and set quickly





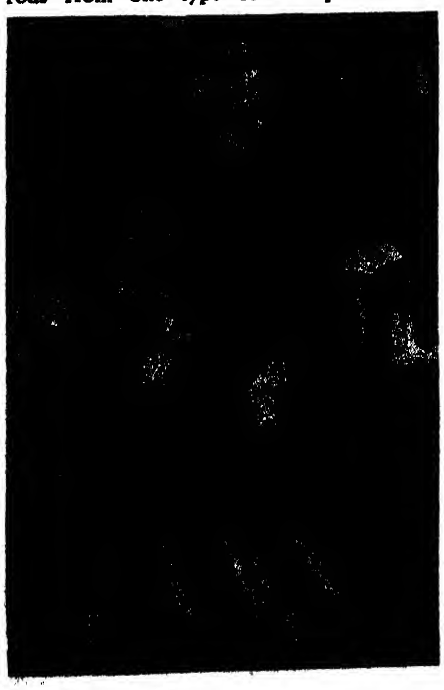
IS BORN

7 It is frequently desired to produce a batch of plastic in which two or more color combinations are blended in irregular mottled patterns. This effect is obtained by an intermediate process after the thick liquid is withdrawn from the kettles and before it is cast. In the photograph, the mottler is skilfully blending two colors to simulate onyx. Measuring by eye, he produces remarkably uniform results in successive batches

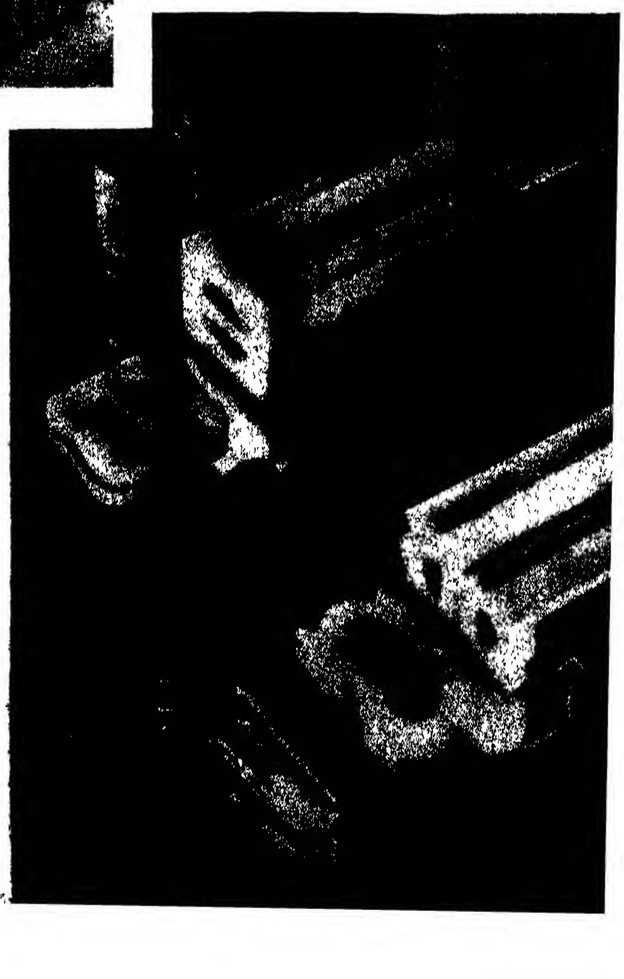
6 Making one form of mold into which the liquid Catalin will be poured. A steel arbor of the proper shape is dipped into molten lead. The lead "freezes" to the steel and is then stripped off, ready for use. Molds are used only once. The form shown is for making rods from which buttons of identical size are cut

8 *Left:* The molds and the cooked plastic are ready. Small quantities of the mixture are conveyed in ladles to the molding bench where the heavy liquid is poured into the waiting lead molds. In the photograph is a series of cylindrical molds; the finished Catalin cylinders will be cut into short lengths and the edges smoothed to form fancy bracelets

9 After the molds have been filled, they are placed in low-temperature curing ovens for a period of about 50 hours. This treatment makes the finished product less brittle, preserves the colors of the delicate dyes. *Below:* After curing, a pneumatic hammer forces fluted plastic rods from one type of multiple mold



10 Molded, cured, and partly sliced, the variety of forms (*right*) show a few of the hundreds of possibilities for plastic products. Umbrella handles sliced from lengths of curved stock, belt buckles and dress ornaments from fluted hollow rods, are suggestive of many other uses. Teething rings and dental plates, doorknobs and toothbrush handles, steering wheels and fountain pens, all can be cast in Catalin or cut to form with the same tools and technique as are used in many branches of wood or metal working



By A. P. PECK

THE NEAREST STARS

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

EVERYONE knows that we must know the distance of a star before we can work out its real brightness, or the actual rate at which it is moving relative to the sun, and it is almost as widely known that the distances of hundreds—nay, of thousands—of stars have been determined in one way or another, so that we can perform the required calculations. These are simple enough: to allow for the average effects of the minute errors which still affect our observations, though not so simple, is practicable. But, when our calculations are all made, and their degree of reliability ascertained, we must think carefully before we apply our results to the stars in general.

For example, it is now quite certain that a majority of the stars visible to the naked eye are 300 light-years or more distant, and that a large fraction, if not an actual majority, of them are at least 50 times as bright as the sun. Is this true of the stars in general? One must meet this question like a Yankee—with another question. "What do you mean by 'in general?'" If you mean the stars picked out by apparent brightness in the heavens, the statement is correct; we have studied a number quite large enough to give a good sample.

BUT if you mean the stars in a given region of space, the statement is very far indeed from the truth. A large majority of such stars are much fainter than the sun. How do we know this? And why do our carefully prepared lists provide us with such an awfully bad sample? The first answer is easy—we find it out by tabulating the properties (brightness, in this case) of the stars which are known to be within a relatively small distance of the sun, such as 20 or 30 light-years, and forgetting the rest for the moment. The question why this method of picking out stars gives us such an extraordinary different sample from the other is more interesting. It does so because there are enormous differences in real brightness from star to star. Suppose, for example, that, on the average, in the region of space surrounding the sun, there are 50 stars as bright as the sun for every one of 100 times the sun's brightness. How many of each sort will be comfortably visible to the naked eye (that is, brighter than the fifth magnitude)? A star of the sun's brightness will satisfy this condition if it is within (approximately) 30 light-years' distance; but a star 100 times brighter will be visible if it is anywhere within 300 light-years. Within this larger sphere (if the stars are uniformly strewn in space), there will be 1000 times as many stars like the sun as there are in the smaller sphere. Hence our apparently fair and simple method of selection gives a most outrageous preference to the stars of greater luminosity. We will get 20 of them in our list of naked-eye stars to one of the other kind—though the real proportion throughout the region of space concerned is 50-to-1 the other way! This is but a mild example of the effects of "observational selection;" some stars are 10,000 times as luminous as others, and stand a million times better chance of getting into our star-catalogues, so long as these are selected on the basis of apparent brightness.

To get a full list of the stars in even the nearest parts of space—say within 20 or 30 light-years from the sun—is therefore no easy matter. There are about half a million stars in the sky between the tenth and eleventh magnitude in apparent brightness. The enormous majority of these must be objects of considerable, or high real brightness, and at great distances. A few dozen among them all will be inherently faint stars which lie close by. To pick them out seems at first to be hopeless; and so it would be, if we had to "go it blind" and measure parallaxes at random for star after star until we happened on a big parallax. But, fortunately for the progress of astronomy, the stars are in motion—and, other things being equal, a star which is near us will appear to move faster across the sky than a distant star. "Other things"—in this case the velocities with which the stars are moving, relatively to the sun, at right angles to the line of sight—are, of course, not always, or even usually, equal. But the range in these velocities, though considerable, is nothing like the enormous range in the real brightness of the stars, so that if we make a list of stars of large proper motion, the preference which we unavoidably give to fast-moving stars will not be hopelessly overwhelming. What is most important for our present purpose is that there will be very few stars whose crosswise motion is actually small, so that, though near us in space, they appear to move slowly in the sky. The reason for this is that this motion has two degrees of freedom. One part (or component) is eastward or westward in the sky, and the other northward or southward; and if their combined effect is to be small, each one separately must be still smaller. If, then, we can get a list of the stars with large proper motion, say more than 0".5 per year, it will include almost all the stars of very large parallax (greater than 0".25), and the major part of those with considerably smaller parallaxes.

NOW stars with large proper motion are easy to find, by comparing photographs taken many years apart, with the powerful aid of the blink microscope, which almost automatically picks out a single star which has moved among thousands which have not. Millions of stars have thus been examined, and thousands of motions detected (most of them smallish) but, among them, there are a few hundred stars with rapid motions. These, whatever their brightness, are promising objects for the parallax observer. The completion of work now in progress—such as the very extensive campaign pursued by Luyten at Minnesota, with Harvard plates—should give us a practically complete proper motion list down to the 15th magnitude, and so lead to a fairly thorough knowledge of the nearest stars.

What we know at present is summarized in a very interesting list which has just been published by Miss Louise Jenkins of the Yale University Observatory. This includes all the stars which are known, by direct measurement, to have parallaxes exceeding 0".1—that is, distances less than 33 light-years. There are 127 objects in the list—not counting the fainter companions of the 19 double and 5 triple systems, which raise the total number of stars known to be within this distance to 156.

We do not get anything like this proportion of double and triple systems among stars selected by apparent brightness. The reason is obvious. Most of these stars lie at much greater distances. If the nearest stars were removed to such distances, some of the closer pairs could no longer be seen double, and many of the fainter companions would

be lost to view, even with large telescopes. Hence the list of near-by stars, short as it is, gives a better idea what proportion of the stars are double than do the far longer lists of stars "including everything" down to some limit of apparent brightness, and hence affected powerfully by observational selection.

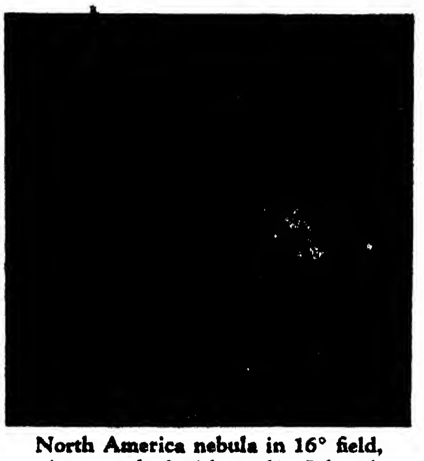
Observational selection has still had a very considerable influence upon the list of the nearest stars. This appears clearly when we pick out those whose distances are less than half the originally assigned limit (and parallaxes therefore greater than 0".2). By this change, we have cut down the volume of space in which we are looking for stars to one eighth what it was before, and should expect to get one eighth as many stars. We actually find 32 systems (six double and two triple), or 42 stars in all. If this is a fair sample of the larger volume, we should have found 256 systems, or 336 individual stars, in the longer list. We actually get less than half as many, so that the list must be very incomplete, especially for distances greater than 20 or 25 light-years. When studies of proper motion and parallax have been thoroughly extended to stars of the 15th magnitude, a larger number of these objects will doubtless be picked up.

If we divide our inner region into two equal volumes by a sphere 12½ light-years in radius, we find 21 systems with 29 stars in the inner part, and 11 systems with 13 stars in the outer shell. Part of this large difference may be due to chance, but it is highly probable that, even for these very near stars, our present list is far from complete. The whole number of stars within 33 light-years is probably as great as 500.

In the present list of near stars, there are seven of the first magnitude: Alpha Centauri, Sirius, Procyon, Altair, Fomalhaut, Vega, and Pollux. This list is complete, for the remaining 14 stars brighter than magnitude 1.5 have been observed and found to fall outside our limit—most of them far outside. Among the naked-eye stars (brighter than $6^{m}.0$), there are 49 in the list (not counting the fainter components of doubles) which is just 1 percent of the whole number in the sky. Our list is probably fairly, but not quite, complete in this case.

The list of 59 stars between the 6th and 11th magnitudes will probably be considerably increased, but, even so, it is certain to include only an exceedingly small fraction of the 800,000 stars in the sky within these limits of apparent brightness. Only 19 stars fainter (apparently) than the 11th magnitude have so far been found to be our near neighbors. Were our list complete, it might be 20 times as long, but it would contain a far smaller fraction of the many millions of stars in the heavens than any of those which precede it.

The range in real brightness among these stars is enormously great. Even among the five nearest stars, we have Sirius, which is 28 times as bright as the sun, and the tiny star Wolf 359. This star is known only by its number in the catalogue of proper motion stars discovered photographically by Wolf, and has the very large motion of 4".67 per year. Its apparent magnitude is 13.5—so that it sends us a little less than a millionth part as much light as Sirius does; yet it is actually nearer than Sirius, its parallax being 0".403 and its distance 8.0 light-years, as against 8.4 for Sirius, so that the real disparity in brightness is a little greater even than it looks—the ratio being 1,200,000 to 1. Sirius is bright not mainly because it is big, but because it is hot. There is good reason to believe that it is rather less than twice the diameter of the sun, and gives out about eight times as much light per square mile. Wolf 359 must be a small star, but it is also one of the coolest stars we know about (except for certain variables). Recent observations, reported at the Williamstown meeting of the Astronomical Society, show that it is far brighter when photographed with red light than it appears to the eye. This indicates a very low surface temperature, probably below 2500 degrees, as against 6000 degrees for the sun. The corresponding surface brightness would be something like 1/1000 of the sun's, and, as the star gives out about 1/40,000 of the sun's light, we may roughly estimate its diameter as 1/6 or 1/7 of the sun's. If its temperature were 2000 degrees, its diameter would come out about half the sun's. The truth may lie between these two estimates.



North America nebula in 16° field, photographed with an f/1 Schmidt camera by Charles and Harold Lower. The North American nebula appears half way between the center and right edge of the photograph. It is a fortuitous arrangement of star clouds resembling the North American continent in its outline

A star similar in brightness and motion to this, but lying in the outer half of the region which we have chosen as our limit for the "nearest" stars, would be of the 16th magnitude visually and not much above the 18th photographically, and have a proper motion of 1".4 per year. By comparing plates made at only a few years' interval, it could be picked out easily from a hundred thousand ordinary stars; but to get plates showing good images of such very faint stars, over a large region of the sky, would demand longer exposures than it has yet been practicable to give for such work. Such very faint stars, then, can be detected only when they are near among the nearest. We are lucky to have caught a single one so far.

Whether there are still fainter stars among our nearest neighbors will not be easy to find out. Random searching is not likely to be profitable, but one chance is worth taking. A good many of the nearer stars have faint companions, sometimes close enough to count as a "double star," oftener some distance away, but recognizable by their sharing the principal star's motion. The fields surrounding these stars in the sky, therefore, afford much better hunting-ground than random samples of the sky, and it might be profitable to photograph them with long exposures, and repeat this after a few years—two or three would be enough to reveal such a companion by its displacement. It would pay, too, to examine the nearest stars visually with great telescopes on good nights in search for close or faint companions. Kuiper has already discovered several interesting pairs in this way.

Four more of the ten nearest stars at present known are less than 1/5000 as bright as the sun. Among them is "Proxima Centauri," the faint distant companion of Alpha Centauri, moving along with it in space, and probably a little nearer to us than the bright double. All these stars are red, and they are probably both small and cold, like the one we have discussed.

Even from this small sample, there can be no doubt that these individually inconspicuous stars are the most abundant of all kinds, if the search is made throughout a given region of space. When we pick stars by apparent brightness, we introduce odds against including such stars as Wolf 359, which, compared with stars like the sun, run nearly 10,000,000 to 1. Compared with Sirius, the odds would be more than 1,000,000,000 to 1, if it were not that Sirius, if at such a distance that it appeared of the 13th magnitude, would be in a part of space where the stars are thinly scattered. This reduces the odds, but leaves them so heavy that it is not surprising that we have so far discovered but a single one of these very faint stars.—*Princeton University Observatory, November 4, 1937.*

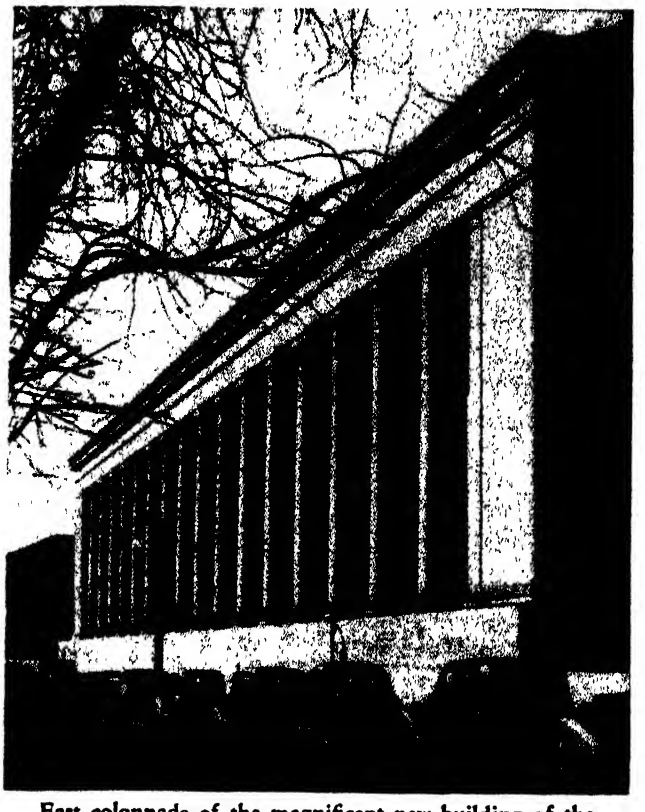
Headache Headquarters

Mellon Institute . . . Sponsored Research Cures Industrial Headaches . . . Solves Problems . . . Develops New Products, Processes . . . 700 Patents

By FREDERICK TISDALE

WHEN a manufacturer is ailing, he calls in his doctor; when he has trouble with his product or process he may call in the Mellon Institute of Pittsburgh. No problem in industrial research is too difficult for it to tackle. Mellon Institute showed the 364,000,000-dollar Union Carbide and Carbon Corporation and the 400,000,000-dollar Koppers Company and associated concerns how to adapt deadly war chemicals to peaceful commerce. For a smaller company it developed a water conditioner that renders dishes germ-free (dish-conditioning) and suggests that every dish-towel in America may some day become obsolete.

By improving the things that millions use and consume, the Institute promises to become the most significant monument to Pittsburgh's late grandees. It was founded by Andrew W. Mellon and Richard B. Mellon. The new structure into which the organization moved last May is the most complete research laboratory in the world (see Scientific American, July, 1937). Its 200 scientists use 300 chemical or mechanical work-rooms. By a turn of the hand they obtain steam, gas, compressed air, suction (for creating vacuum), water at any temperature, tropic or arctic weather conditions. They have solved headaches for 4000 companies, developed 650 new processes. Some 700 United States patents have been granted on the results of their labors and many of these have been revolutionary.



East colonnade of the magnificent new building of the Mellon Institute of Industrial Research at Pittsburgh

Mellon Institute works through industrial fellowships which are financed by individuals, companies, or associated groups. Donors of fellowships may use all facilities of the organization but they pay according to the needs for personnel and special apparatus. Contracts run for at least a year. All patent and other rights belong to the fellowship donor.

The Institute chooses the best available scientists to head the fellowship activity. Most of them are young chemists or engineers with brilliant records. They come from universities, company laboratories, government and association services. Discoveries eventually worth millions to the country are sometimes made by groups whose head "fellow" gets around 6000 dollars a year, but there always is a chance that these men may graduate into good jobs with grateful clients. Mellon Institute requires about 1,000,000 dollars a year for running expenses. Fellowship donations help make up this figure.

SPECIALISTS working in such huge modern laboratories are displacing the colorful lone inventor who groped (and hoped) in poorly-equipped scientific hide-aways. Mass attack by trained men now solves the technical difficulties of industry. Co-operation among them speeds results.

Since the organization's most important field is industrial chemistry, its handiwork often goes unrecognized by the consumer. A housewife discovers that by adding a spoonful of "Calgon" to dishwater, her glassware and china dry miraculously bright and clean without the aid of a towel. This substance forms a perfect solution of soap with any water, no matter how hard, and enables it to drain off without leaving any film or dirt. Mellon Institute discovered that the addition of sodium hexametaphosphate to dish-washing compounds gave the magical results.

At Coney Island a pants presser treats his girl to a skinless hot dog, never suspecting that distant Mellon scientists made the delicacy possible. Probably he does not know either that the clothes pressing machine he uses daily also is indebted to Institute engineers for up-to-date improvements. It took 10 years to perfect a cellulose casing for wieners that would take the place of animal intestines. E. O. Freund, who later organized the Visking Corporation, of Chicago, backed the venture. Success involved devising a machine that forced out cellulose of definite properties in an endless tube, much the same as rayon filaments are produced.

This cellulose comes from cotton linters, is a cousin of Cellophane. Meat does not stick to cellulose as it does to animal casings. Therefore the frankfurter's cotton shirt is removed after the sausage is cooked, smoked, and stuffed in the orthodox manner. The result is a nude "frank" ready for boiling and the valedictory smear of mustard.

Thirty-one men, 15 of them Mellon scientists, made daily sacrifice of their beards in a shaving clinic under the Magazine Repeating Razor Company fellowship. It was found that a tooth-type guard traveling ahead of the blade rumpled the skin, thereby preventing a

close cut in the grooves and causing painful nicks on the summits. A bar guard which stretched the skin smoothly and raised the whisker for better contact with the blade was developed. Also, the most generally agreeable angle between blade and skin was scientifically determined (see Scientific American, November, 1937).

Research on the fundamentals of sleep for the Simmons Company illustrates the ingenuity required for designing special apparatus. A sort of posture meter was invented to register how long a subject lay in each position. It consisted of a noiseless motor which slowly moved a tape under the bed. On this rested a pen which was attached to the bedsprings. The pen-point drew a straight line as long as the sleeper lay still, jogged whenever he moved. Comparison with a time line on the tape registered how long each posture was kept.

Exact positions were observed and timed by a camera aimed through a hole in the wall. Whenever the subject moved and disturbed the bedsprings, an electromagnet snapped the shutter. Each exposure took in a wall clock, thereby recording the time and duration of different postures. Subjects included 150 persons, of both sexes, of varying ages, intelligences, and states of health. It was discovered that normal persons change posture 20 to 60 times during a typical night. The only healthy person who "slept like a log" was insane. Simmons Company was given the analysis of two million measurements to guide its designs of sleeping equipment.

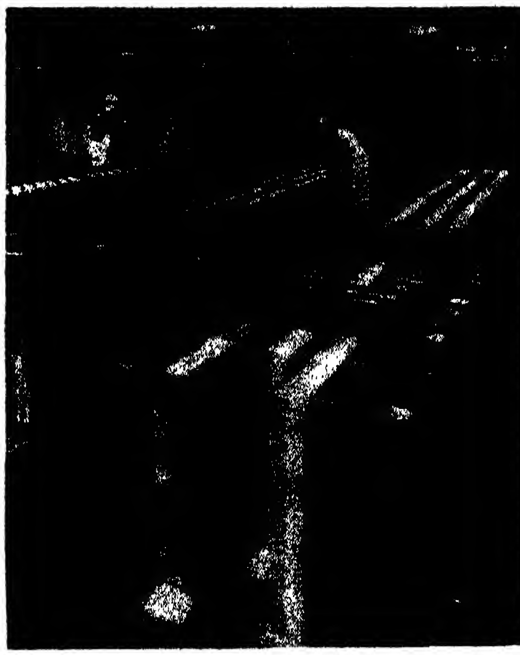
Mellon Institute developed flake coffee as a by-product of packing experiments for Continental Can Company. Ground and roasted coffee was passed between heavy rollers. Resulting flakes were about as thin as a piece of paper. Flaking crushes the coffee cells, yields about 96 percent of desired essentials, compared with about 60 percent from ground coffee.

"Fly-Tox" was developed at Mellon Institute. It was the first insecticide of this type to be distributed nationally to consumers. Formerly, manufacturers could rely only on the "death chamber" to establish the insect-killing qualities of their poisons. It is a specially constructed room, six feet cube. For a test 100 flies are imprisoned in it. Then 12 cubic centimeters of the insecticide are sprayed in. After 10 minutes the flies (mostly in a stupor on the floor by now) are taken out, put in a cage, and the interval until death timed. A good fly poison will put 95 of the 100 flies on the floor after 10 minutes and kill 60 within 24 hours.

Chemists felt that a simpler and more accurate test could be devised. Mellon Institute developed standards for the ingredients, particularly pyrethrum extracts—from a variety of chrysanthemum flower. By this method, manufacturers now predetermine with scientific precision the lethal qualities of their insecticides.

For Heinz, the Institute developed "Rice Flakes" breakfast cereal. Pure cellulose, recovered from the rice hulls, is added to give it laxative qualities. Heinz strained foods was another activity. These retain in puree form practically all the vitamins. They are in great demand for babies, children, persons on soft diets. One of the combinations of strained green vegetables contains lettuce, kale, asparagus. This mixture is rich in calcium value. It is superior to spinach which interferes with calcium utilization.

Millions munch their morning toast without appreciating the Institute's contribution to commercial bread making. "Arkady" yeast food revolutionized this branch of the baking industry. It literally feeds the yeast (with necessary nitrogen, lime, and oxygen, which other-



Making the casings, above, for the "skinless" hot dogs, a product of Mellon research. The girls are peeling off the skins of the "franks" after cooking

Manner in which the bursting strength of hosiery is determined in the Mellon laboratories

Machine employed in making strength tests on various textiles

wise must be slowly taken from the other dough ingredients). There is a saving of one half in yeast used or about one half in time required to make the bread. "Arkady" cuts the fermentation time from five hours to two and one half.

Kaufmann's Department Stores, Pittsburgh, uses the Institute for development of merchandise standards. Results guide the store in buying from manufacturers, and tags inform customers as to the quality.

In one of the Institute's laboratories, a lever monotonously raises and drops on an inner-spring mattress a small barrel containing 100 pounds in weight. The blow travels 10 inches, 10 times a minute. On one mattress the meter registered 50,000 thumps without causing serious damage. Silk stockings and other fabrics are tested with a machine having an expanding rubber disk, thus registering the pressure necessary to burst through them. Gaged weights on individual threads determine tensile strengths. On the rocking arm of another apparatus, cloth is rubbed at set tensions and weights, a counter indicating how long it would take trouser seats to acquire a shine or upholstery fabrics to wear through. Fading resistance of dyes is determined by exposing cloth samples to a carbon arc lamp producing the same quality of light as the sun. A machine designed for determining air resistance of parachute fabrics has been adapted to show the air porosity of summer clothing textiles. It measures the time required for a given amount of air to pass through the weave.

Mellon Institute pioneered in disclosing the causes of cloth failure during laundering. Standard washing formulas were given the industry and scientific reasons were established for explaining fabric injuries to customers.

THE Institute's development of silk strings for tennis racquets should be welcomed by the nation's sheep—not cats, as popularly supposed—as promising relief from a painful responsibility. Through research, slag waste from steel operations has been adapted for building purposes. Experiments on 350 types of brick walls disclosed among other things the trouble caused by moisture seepage above and below, developed types of metal flashing to prevent it. A fellowship discovered that the addition of 10 percent copper powder to magnesium oxychloride cements (used in floors, tiles, stucco, and so on) produced an amazing new cement which, unlike the original mixtures, grows stronger under exposure to water and weather; it's called "Hubbellite."

Mellon has been active in the development of plastics, new and mysterious big business. Its early product, Redmanol, was later combined with Bakelite's operations. This is a phenolic, at present one of the important synthetics in the plastic field. Its antecedents are carbolic acid (or phenol from coal via coke) and formaldehyde (compound formed from wood alcohol and oxygen). Other plastics developed at the Institute include Plaskon, Vinylite. They are competing with older materials in table tops, airplane windows, table wares, automobile accessories, electrical fittings, machine casings, gift novelties, costume jewelry, and many other commonplaces.

While industrial research is Mellon Institute's back-log, it also busies itself directly in behalf of humanity. An example is its air pollution study which began in 1911, the year the Institute was founded. "Snap shots" of air are taken by a suction pump which traps samples in a chamber of about a half-pint capacity. An electric precipitator also may be used. Each particle in the air carries a charge of electricity; plates in the device act as a magnet to draw down each tiny floating bit.

Particles are counted, measured under a microscope. A tobacco smoke particle magnified 5000 times is about the size of a pin point. Safe air contains 200,000 to 300,000 particles per cubic foot. Very dirty atmosphere runs as high as 500,000,000 particles. By co-operating with industry, Mellon Institute has helped reduce the precipitation of soot in Pittsburgh to under 1000 tons per square mile per year. Its findings guide cities to more intelligent anti-smoke ordinances, industrial plants to better firing equipment.

Since pure air is as important to health as pure water, the rise in steel activity in the Pittsburgh area always means more work for the community's doctors. Lung ailments increase. Ravages of pneumonia in Pittsburgh incited Mellon Institute to seek a cure. It recently announced a treatment that cut the mortality in half when tried in 200 pneumonia cases. Starting from German discoveries in 1911, Mellon experimenters under Dr. W. W. G. Maclachlan produced the effective drug. It was awesomely christened Hydroxyethylapocupreine. In practice they just call it "Number 71."

This drug is a derivative of quinine. Cinchona chemicals originally used caused blindness in doses strong enough to kill germs. Mellon Institute overcame the difficulty by adding a group of atoms known as the hydroxy radical to the complex quinine molecule. Twenty thousand white mice were the heroes of this successful microscopic war.

An experimental sleeping room used in studying a sleeper's changes in posture. The clock timed each change on each of the pictures that were made

Floated on Mud

Sailing Vessel, Now an Aquarium, Was Raised to a Permanent Location by Mud . . . Nine Feet Up . . . Cofferdam Used . . . Sand as a Foundation

By HAROLD CHAMBERLIN

Prins Valdemar **in the coastal service during the Florida boom days**

HIGH and dry and safe and sound on the Miami waterfront the good ship *Prins Valdemar*, German blockade runner of World War days, has come to her final anchorage at last. Like every other incident of her long and varied history, the closing chapter in the seafaring life of *Prins Valdemar* was of unusual interest, for instead of sinking to her end she took an elevator with mud as the motive power and was raised to her resting place.

For years the once proud vessel was tied to the seawall in Miami harbor, her decks paced curiously by visiting tourists who thrilled at her story while inspecting unusual specimens of marine animals displayed by the aquarium housed aboard her. Now *Prins Valdemar* has said goodbye to the sea. Her owner had a problem, however, to move her 250 feet of length and 4,000,000 pounds of dead weight into the position desired, for he wanted to raise the ship nine feet above high tide.

By building a cofferdam out from the land and surrounding the vessel, it was possible to float the boat up six feet, but the three feet additional presented a problem. Finally this was solved by floating her in mud. In salt water the vessel drew 15 feet, but in thick fluid mud the draft was reduced to 12 feet. Therefore, after the ship had been raised six feet in water inside the coffer dam, the water was gradually displaced with mud.

Every day as the task proceeded, the vessel would rise as the greater specific gravity of agitated mud took hold of her. Every night as the mud in the mixture settled to the bottom some of the lifting power would be lost and the ship would sink back. In the end, however, she was hoisted the required distance and heavy sand forced in beneath her keel to hold her solidly in place and provide a firm foundation.

Built in Sweden of English iron, *Prins Valdemar* sailed the seas when forests of tall spars still spread canvas to the winds. During the war she once ran the Allied blockade successfully, then barely escaped capture a second time by hustling into a Danish port. The Florida boom saw her pressed into service hauling hotel and building supplies south from New York, and one voyage ended with her conversion into a floating hotel of 100 rooms. In a storm she capsized, sank, and for months partially blocked the Miami ship channel; then she was raised to become a floating aquarium. But her last voyage was up—and it was sailed in a sea of mud.

Above: A view of the stern of the vessel, showing the cofferdam, the old waterline, and the "mud-line." Below: *Prins Valdemar* is now on solid foundation

WHAT TO DO ABOUT DUST?

Industrial Dust Hazards . . . Little Known of Them...Foundation to Study Ways, Means of Combating . . . Medical, Legal, Engineering Aspects

By JOHN F. McMAHON
Executive Assistant, Air Hygiene Foundation

DUST might be roughly described as the "airy particles" arising from a world that is wearing away under the ceaseless erosion of nature and the onrush of restless man.

The physical world is, of course, composed of matter in many forms. Dust, in a broad sense, is simply the tiny remnants resulting from the breaking up of this matter. It is the product of that tireless process of wearing out which walks hand-in-hand with time and affects life, mountain tops, and all material things. Dust is one of the common denominators of the world and exists, potentially, in every solid object. Even man is made of dust, according to the Scriptures, and unto dust he ultimately returns.

Thus certain fine, powdery particles are a part of the natural order and might be called natural dusts, since they are independent of man. Examples of such forms of air pollution include withering dust storms searing the country side or miniature particles of plant and animal life afloat in the air.

Far more dangerous than these, however, are the man-made dusts generated in the industrial processes of our highly industrial era. Besides the "chimney sweeps" of incomplete combustion—smoke, ash, tar, and so on—there are the numberless industrial dusts. The use of abrasives to clean and polish metal, abrasive powder and abrasive soap making, foundry work, sand blasting, quarrying, tunnelling, mining, glass making, and pottery making are among the "dusty trades."

The stone cutter of old, hacking at hard rock with a pick or with hammer and chisel, had little to fear from dust. The modern stone cutter, thundering through brittle rock with power drills, stirs up smoke-like waves of dust. Unless properly protected, he may inhale harmful quantities of dangerous silica particles. Some of these drills are known among miners as "widow makers."

THE United States Public Health Service estimates that approximately 1,000,000 workmen are exposed to silica dust in America's mines and mills—a dust which, breathed in sufficient quantities and over a sufficient period of time, may cause silicosis and other disorders of the respiratory organs. The inhalation of dust may, under certain conditions, weaken man's resistance to tuberculosis, colds, bronchitis, pneumonia, and sinus troubles. Men working in dusty trades suffer more from such ailments than men working elsewhere. "The evidence that excessive dustiness of any kind is harmful is beyond argument," according to Prof. Philip Drinker of the Harvard School of Public Health.

Of the estimated 1,000,000 workmen exposed to silica dust, approximately one half of this number is exposed to harmful concentrations. In addition to silica, there are numerous other dangerous dusts, such as lead dust or asbestos dust.

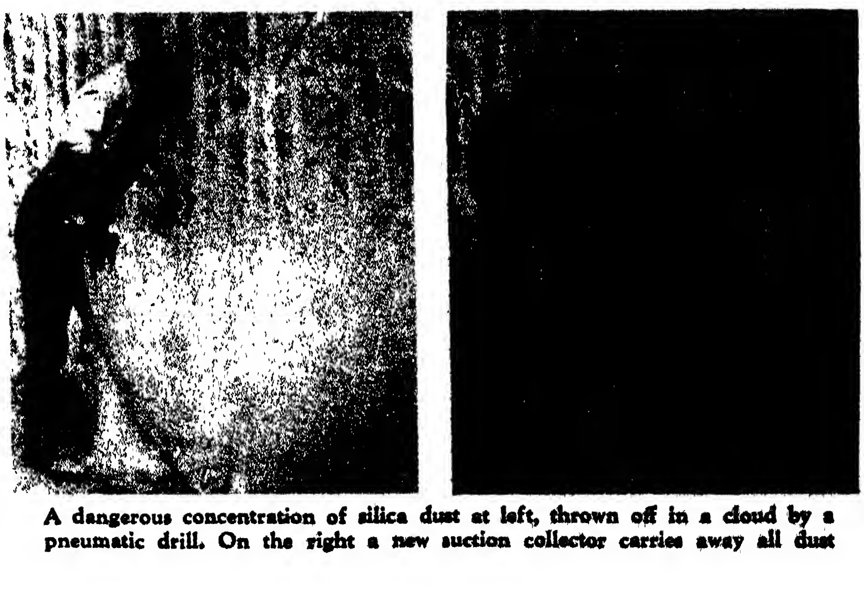
It was not until about two years ago that the general public in this country became acutely conscious of dust as an enemy to health and a cause of occupational disease. This realization followed the wide publicity given to silicosis cases in connection with a tunnelling project at Gauley Bridge, West Virginia.

But prior to this general awakening, with its accompanying panic and hysteria, a number of industrial leaders representing the steel, foundry, glass, ceramic, pottery, refractory, aluminum, coal, and metal mining industries began meeting and discussing ways and means of combating occupational diseases. An epidemic of ruinous lawsuits was sweeping the country. Many firms were forced out of business entirely. The industrial areas about St. Louis and Rochester, New York, suffered severely. Insurance rates were mounting as a result of the many claims.

IN the face of these developments, industry, perplexed and often bewildered, knew not where to turn for help or guidance. Even noted physicians frequently disagreed as to the medical aspects of the problem. Engineers, attempting to devise equipment to dispose of dust, were hampered by this inability of medical men to say just what concentration of a given dust constituted a hazard to health, and just how low the concentration should be cut to make a reasonably safe working place.

Consequently a score of firms and trade organizations banded together and established the Air Hygiene Foundation of America, a non-profit, scientific organization created to conduct research on silicosis and kindred industrial diseases. The Foundation, in its search for the vital knowledge needed to combat these ills, is not only engaging in research itself but is attempting to collect into one central reservoir the fruits of experience and research which have accrued heterogeneously everywhere.

After getting underway early in 1936,



A dangerous concentration of silica dust at left, thrown off in a cloud by a pneumatic drill. On the right a new suction collector carries away all dust

the Foundation immediately launched a program of fact-finding searches in the three fields bearing upon the problem—medicine, engineering, and law.

The medical survey, for example, involved the evaluation of findings gleaned in a number of industries, in hospitals, and in research centers here and abroad. It concludes that on the basis of present knowledge, nine points are definitely known about silicosis. They are:

1. Silicosis results from the inhalation of dust containing free silica.
2. The time required for the development of silicosis varies from a few years to 20 or more, depending upon the concentration of silica particles in the air and the length of exposure.
3. Beginning silicosis is recognizable only by properly taken roentgen films (X rays) of the chest.
4. Associated with silicosis is a marked predisposition to tuberculosis.
5. Silicosis can be prevented by protecting the industrial worker from inhaling silica dust.
6. Concentrations to which dust must be reduced in order to be safe have not been absolutely determined.
7. Industrial dusts, containing silica, are frequently not all silica, being mixed with other materials. Some of these may alter the silica action on the body.
8. Asbestos, a silicate, is the only dust other than free silica which has been shown to cause lung fibrosis.
9. Simple—that is, uncomplicated—silicosis, as seen in the industries in this country, causes relatively little severe disability. It is its combination with other diseases which is serious.

The report of the preventive engineering survey warned engineers to center their attack on the smallest dust particles, pointing out that, in a general sense, the finer the dust the greater the potential danger.

The legal survey examined the statutes and court decisions of each of the 48 states in an effort to establish the exact status of the law in each state as regards occupational disease due to air pollution. This review disclosed sharp conflicts between the laws of the various states respecting compensation for occupational disease. It noted, however, a growing liberal trend toward compensating workmen who contract industrial disease just as workmen injured in industrial accidents are compensated.

THE occupational disease question is so broad, with its social and economic implications, that many of the 44 state legislatures which met last year considered the problem.

Further, as pointed out in the Summary Report of the Economic, Legal, and Insurance Committee of the National Silicosis Conference, "increased costs for preventive or compensatory measures may have marked economic effects upon the relative position of competing industries or units." Obviously a manufacturer in a state with stringent regulations is placed at a disadvantage with a competitor in a state where few such regulations exist. This disadvantage promises to be temporary, however, and may be offset even now by the cost of damage suits.

Aside from the economic consideration is the even more important social or human factor. If a workman contracts an occupational affliction, his wife and his children suffer indirectly, as does the whole community. The United States Public Health Service has shown that the life expectancy of industrial workers is several years less than in the case of other workmen. Pneumonia rates are twice as high and tuberculosis rates are much higher for the industrial group, which roughly comprises some 15,000,000 persons employed in manufacturing and mining.

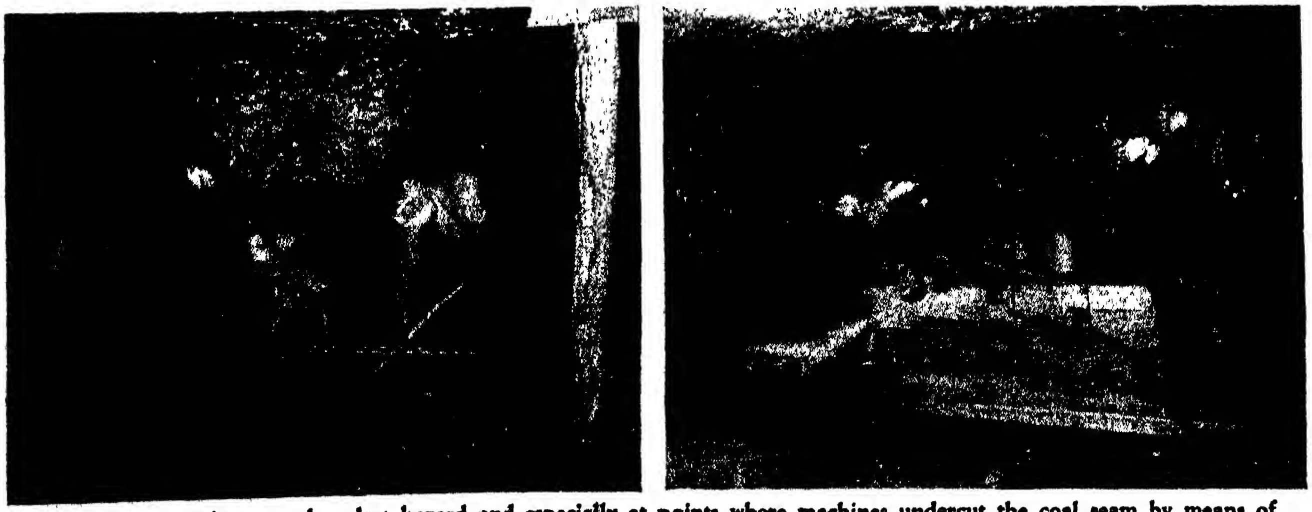
This situation further emphasizes the need of a coördinating and correlating research center dedicated to the development of sorely-needed information on the cause, cure, and prevention of airborne occupational diseases. Possessed with the findings of its inventory-like surveys, showing, roughly, what is known and what remains to be sought out, the Air Hygiene Foundation was able to lay out a practical program of scientific research into the fundamentals of industrial air pollution.

The research is to be carried on at institutions deemed best fitted for the particular task in mind. Some of these are the Saranac Laboratory, Saranac Lake, New York; University Hospital, University of Pennsylvania, Philadelphia; United States Bureau of Mines, Washington, D. C.; Harvard School of Public Health, Cambridge, Massachusetts; Singer Memorial Laboratory; and Mellon Institute, Pittsburgh.

This program, recently announced, seeks to answer many puzzling questions on the medical and engineering aspects of the subject. Some of these include:

I. What is the mechanism by which silica acts upon the body? Is silica a poison or an irritant? Is the action of silica physical, as in cutting, or is it chemical?
II. What is the relation between silicosis and tuberculosis?
III. What is the effect of other substances upon the action of silica? (It is claimed that some dusts retard the action of silica, apparently diluting its effect, while others are said to speed up the silica action.)
IV. Determination of hood design data for various dust-producing processes involved in the crushing, grinding, and general handling of rock.

Another problem calls for the development of a fool-proof technique of roentgenography (X ray). It appears that pre-employment medical examinations including a chest roentgenogram will be required of workmen to an ever increasing degree in the future. Thus a man may be hired or rejected on the basis of his X-ray film. Therefore, the best possible technique that can be evolved is the least with which employers can be satisfied.



Coal mines constitute another dust hazard and especially at points where machines undercut the coal seam by means of powerful cutting teeth on a flat arm. At the right, this operation is rendered dustless by a spray of water on the cutting arm

CHEMOTHERAPY AND PRONTOSIL

Uses and Abuses of the New Drug...Valuable, but to Be Used with Caution...Theory of Chemotherapy... Hope for Other Drugs in Research on Same Theory

By T. SWANN HARDING

SUPPOSE you were an officer of the law charged with the duty of arresting the Purple Gang. This gang is composed of individual units who may be likened to toxic agents or poisonous bacteria ready to make society ill. Their trail leads to a dance-hall full of people. But you are alone. The task of arresting these members of the Purple Gang, scattered as they are among many innocent people, seems hopeless.

Ah, but you have a magic revolver loaded with charmed bullets. These are like the famed silver bullets of savage witch doctors. You can aim the revolver, pull the trigger, and release several of them, and each will emerge, unerringly search out a gangster, and paralyze him temporarily. The bullets will not harm anyone else than members of the notorious Purple Gang.

Once the gangsters are paralyzed the rest is easy. You simply arrange to have them hauled off to jail while they are for the time impotent to do harm, and there you are. There also you have a fair example to illustrate what physicians who use chemotherapy with care and intelligence can often accomplish.

Prontosil, the official name of which is sulfanilamide, the substance about which there has been so much in the newspapers recently, is such a chemical charmed bullet. Doctors are now shooting it at the gangster germs that cause meningitis, childbed fever, pneumonia, gonorrhea, pyelitis, but chiefly various infections caused by germs known as streptococci.

The substance does not kill disease germs. Instead, it prevents their growth and multiplication within the victim's (or host's, as the merry pathologists say) body. It paralyzes them in the dance hall. Then the body's own fighting forces get to work and conquer the infection.

NATURALLY, newspaper reports have often been sensational and exaggerated. For example, the drug was much publicized when used in the illness of the President's son. But readers were not told that only a few doses were given, that these availed nothing, and that surgery was resorted to.

The drug also has been abused. It is a powerful and dangerous agent. Publicity regarding its use in gonorrhea has, unfortunately, led laymen to buy it at drug stores for self-medication. State and city ordinances should prohibit its sale except on prescription, and it certainly should never be used by laymen for self-medication. [An editorial on this drug appears on page 9.—*Ed.*]

Some uncritical doctors themselves have tended to discredit Prontosil by using it in all sorts of infections. Even dentists have used it promiscuously. One must always take stories of marvelous new remedies with a grain of salt. Nevertheless, there is a nugget of truth here that deserves a little careful exposition.

Chemically, this drug is a dark red dye called the hydro-chloride of 4′-sulfamido-2:4-diamino-azo-benzol. It was discovered by Domagk in Germany about 1935. He called it prontosil, a word that has since been adopted as a commercial trade name by one American firm. The correct official drug name is, as was said above, sulfanilamide.

But, in order to enable us to understand the manner in which this drug acts, we must briefly examine chemotherapy as a whole. While it is usually supposed that this form of therapy took its start with Paul Ehrlich, it started much earlier in folklore and primitive medicine. The Brazilian Indians of Pizarro's time actually practised chemotherapy empirically when they used cinchona, which contains quinine, as a specific against certain kinds of malaria, also ipecac, which contains emetine, in certain types of diarrhea. In such cases a magic chemical bullet was fired at germs that caused certain diseases in the body, in order to destroy or combat them without injury to the body.

Chemotherapy is, then, the treatment of internal disease by the use of chemical substances which have a specific and immediate toxic effect upon the microörganisms that cause the disease, but which do not seriously poison the patient. (They may do him a little unintentional injury but it should not be great. For example, a substance called optochine, when used to treat certain types of pneumonia, caused serious though frequently only temporary blindness. That is something like the three-powder treatment for heart trouble invented by a movie "doctor." The first powder cured the heart trouble but unbalanced the patient's mind; the second restored his sanity but blinded him; the third restored his eyesight but injured his heart. Chemotherapy has to avoid such contingencies as this.)

Scientifically, chemotherapy did get its start with Ehrlich. Facts standing alone—such as that quinine cured malaria—lack the usefulness and significance they have when organized into scientific hypotheses. Ehrlich's theories and hypotheses put facts to work in this field.

PAUL EHRLICH was a German Jew, born in Prussia in 1854. After he obtained his medical degree he devoted himself to pathology. He sought to learn the nature of diseases by examining the organs of the body, in order to determine the effects of various diseases upon them. Naturally, he used a microscope with which he observed very thin slices or sections of tissues from the various organs and even then, as now, they were stained with dyes. These dyes were used in order to make certain structures visible to the observer. This is because they are selective. That is, they stain only certain types of tissues or certain parts of cells or, as was soon found, only certain bacteria. Thus, certain bacteria are called "Gram-positive" because they will hold a certain purple dye when stained with it by the method of Gram, a Danish physician. But, with the growth of the German dye industry, many new synthetic agents became available with which Ehrlich could experiment.

In 1890, Ehrlich had returned from Egypt, whither he went to recuperate from tuberculosis, and entered the Institute for Infectious Diseases in Berlin, under Robert Koch who discovered the germ of tuberculosis. About this time there was much study of antitoxins which fought the poisons produced in the body by diseases such as diphtheria and lockjaw. The antitoxins were so called because they seemed to neutralize the poisons or toxins of disease and render them impotent to harm.

That gave Ehrlich the germ of an idea. Soon he had organized various facts into

his great theory of immunity. In the very simplest language this theory held that disease was basically chemical in nature and that chemicals might be set to fight chemicals. Since very recently the viruses causing certain diseases have been found to be chemical substances, non-living but autocatalytic proteins that can somehow manage to reproduce themselves in certain tissues, the theory assumes more importance now than ever.

Ehrlich reasoned that both animal or tissue cells and bacteria were composed of complex chemical substances. Such substances are formed of very large aggregations of molecules—maybe a hundred thousand or so. When they react with one another they do not pitch into the reaction wholeheartedly, as would simple substances like table salt and sulfuric acid but, instead, they react through certain of their suburban side chains or trailers of their molecules.

However, such reactions can cause a great change in the nature of the complex chemical substance. If it were poisonous, they could perhaps render it non-poisonous. The problem was one of finding the silver bullet that would hit the gangster target while harming no one else in the dance hall. In other words, the problem was one of getting some chemical that could be given to the sufferer from a disease which would detoxify and render harmless the agents causing the disease, but without injury to the victim.

YET, remember, the body tissues and the germs themselves that cause disease are probably a good deal alike. They both contain proteins. They are both, chemically speaking, complex substances. But, since the dyes would enter a mouse, for example, and unerringly pick out germs of a certain type, staining only these particular germs, why would it not be possible to hitch some other substance, deadly to the germs, right on to the dye and thus paralyze the germs? That was Ehrlich's idea.

At that time the dreaded African sleeping sickness (not the disease commonly called sleeping sickness in the United States) was attracting much attention. It was caused by a one-celled animal, the trypanosome, which was easy to find in the victim's blood. So Ehrlich went after that trypanosome, using about 500 different dyes combined in various ways with arsenic, antimony, and phosphorus. He was unsuccessful.

In 1905, however, he took up the study of an arsenic-containing drug called atoxyl, which was said to be non-poisonous. It was used in treating sleeping sickness, but it endangered the patient's eyes. He proceeded to make small changes in its composition and finally, in 1907, his 606th trial was successful. Salvarsan, since called 606, appeared.

Next, Ehrlich proceeded to a great discovery by proceeding upon a totally erroneous theory. He supposed wrongly that the agent causing sleeping sickness was closely related to the one causing syphilis. Hence, if his 606 would cure one of these diseases it should cure the other. Actually it did, even though the organisms involved were not closely related, and the rest is history.

Salvarsan or 606 became the parent and grandparent of numerous other arsenicals. Tryparsamide was perfected at the Rockefeller Institute in the United States. Later mercurochrome-220 appeared, in which a dye was combined with metallic mercury, obviously based on Ehrlich's faith in the antiseptic powers of dye compounds.

AFTER the accompanying article had been written, and while it was being prepared for publication, the newspapers of the nation contained day-by-day accounts of many unfortunate deaths caused by an elixir of the sulfanilamide around which the article centers. While this in no way affects anything in the article, it calls for a clear explanation, and this will be found on page 9.—*The Editor.*

Recently, the attack of chemotherapy has shifted to the field of the dangerous streptococci, which exist in many degrees of virulence and have long baffled medicine. These Gram-positive organisms occur in pairs or chains. Some of them can ripen cheese or sour milk; others cause scarlet fever, erysipelas, childbed fever, and blood poisoning in human beings, mastitis in cows and strangles in horses. They attack numerous tissues and are exceedingly difficult to destroy without injury to the victim. They are the micro-gangsters against which modern witch doctors now aim their silver bullets. Domagk of Germany first used the dark red dye, which he named prontosil, to combat hemolytic (red-blood-corpuscle-destroying) streptococci in mice, the germs being of human origin. In France other investigators claimed success with a similar dye. The drug from Germany was used in Great Britain in 38 cases of puerperal or childbed fever, all results being reported favorable.

Further studies tended to elaborate and confirm these results. In the United States prontosil has been used to combat the organisms causing scarlet fever, erysipelas, otitis media, tonsillitis, puerperal infection, chronic impetigo, pelvic peritonitis, and so on. More recently it is said to have been used successfully to combat the meningitis germs and those causing certain types of pneumonia. It is used both in tablet form orally and in liquid form by injection.

The Mellon Institute of Pittsburgh began work on pneumonia and streptococcic infections about 1926. In 1930 efforts were made to produce a quinine salt that would inhibit the growth of pneumococci but would not damage the patient's vision. A general survey was made of natural and synthetic cinchona derivatives, and those that foreshadowed success were tested. By June, 1937, more than 76 chemical preparations had been made, tested first on pneumococci in test tubes and then with infected white mice. Some 20,000 white mice unintentionally gave their lives to science. At present, one of the compounds called hydroxycupreines offers the greatest promise. Some 200 cases have been treated in human beings and several lives have been saved that would otherwise have been sacrificed to pneumonia. Several years more will be required for full testing. The compound must be produced in large-scale lots, and clinical trials must be conducted on a wide base.

THAT the drug will be abused, even by some over-enthusiastic physicians, goes without saying. Certainly no layman should for a moment think of trying to medicate himself with these compounds at present. *See your doctor* still holds good.

Prontosil was presented at the meeting of the American Medical Association in Atlantic City in June, 1937, as curative of the serious and troublesome urinary tract infection called pyelitis. Cases were reported as completely cleared up at Mayo Clinic by the use of this sulfanilamide.

The substance apparently checks the growth of all the round germs of the coccus family. It is the silver bullet charmed by the modern witch doctors and certain to seek them out and prevent the growth and multiplication of these germs. These developments all form further justification for Erhlich's theory of chemotherapy. They likewise presage a great future for medical therapy. In time, medical research workers may be able to predict in advance, quite theoretically, the kind of complex chemical compound that should be able to seek out and overpower particular germs. Then the compound can be made and turned loose in the body of the germs' involuntary host to seek them out and destroy their power for evil without injury to their victim.

But we must remember that many remedies tend to rise in a blaze of glory and later to sink into disrepute. For a time they seem to be panaceas, magic waters of health, utopian cures for all ills. But more careful and discriminating study usually damps the fire of early enthusiasm. Medical therapy gains by slow, patient accretions of knowledge. It never leaps to universal success at one bound.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

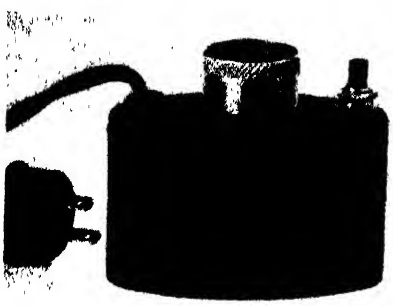
ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

Adjustable Electrical Magnifier

AN innumerable variety of inspection jobs may be performed with unusual ease with a new illuminated magnifier just placed on the market by Lincoln Optics, of Chicago. It is different from others now available in that the lenses are adjustable.

This magnifier is in the form of a metal cup in the top of which the lenses are mounted in a barrel which screws in or out as may be necessary for focusing. A tiny electric lamp under this "hood" illuminates the inspected object without glare, electricity being supplied from the 110-volt lighting circuit. The manufacturer states that the lenses are of optical glass, precision ground so that distortion is prevented.



Small objects are illuminated and magnified in this compact device

This device is designed for close observation of pictures, films, textiles, maps, identification marks, bank notes and checks, postage stamps, and many other things requiring close examination by business or professional people.

Progress and Peace

IN the hurry and bustle of modern living and working, few stop to think of progress as a product of peace, or to realize that the future of civilization is fully dependent upon renouncing war as an instrument of national policy—as soon as is humanly possible. It is the aim of the Hopper Peace Foundation, under the direction of W. Earl Hopper at Oglethorpe University, to emphasize this important fact. The scientific section, known as the Hall of Science and Industry, has as its main objective the furthering of the cause of peace and amity among nations by a true interpretation of the word "civilization." In this respect it differs from, goes a step further than, most such institutions. Many nations of the world have already contributed to the Hall exhibits which they believe most clearly personify the national cultures. Industrialists and manufacturers of many kinds of products have also added their contributions. The Foundation asks that any who may be interested in lending their aid write for further details.

NOISE

SOUND engineers are now putting an end to kitchen clatter. Monel sinks are sound-deadened, the entire under-body being coated with a special compound which sound-proofs all surfaces.

Alcohols from Sugar

LONG a mainstay of inorganic industry, electricity has now invaded the organic field with important results. The reduction of sugars to corresponding alcohols is not a new reaction, having long been accomplished with alkali metals in ethyl alcohol solutions, but now it is being carried out on commercial quantities of sugars by electrolytic means.

Crystalline dextrose, itself a relatively new commercial product, supplies the sugars for reduction. From this very pure raw material, dissolved in pure distilled water with the addition of salts to impart conductivity, direct reduction in the cathode compartments of electrolytic cells produces hexahydric alcohols.

The two hexahydric alcohols thus made are finding uses of growing importance. Mannitol is nitrated to a valuable explosive. Sorbitol has two principal values. As a moistening and softening agent it is used where its very strong humectant properties are significant. In this field it competes to some extent with glycerol, but at a higher price justified by its greater efficiency as a softening agent. Textile problems are solved and the soft glue rolls used to spread printing ink on type are improved through the use of sorbitol. Sorbitol is also valuable as an intermediate in synthesis. Most important of its derivatives at present is ascorbic acid (vitamin C), made on an increasing scale. The fields of use for hexahydric alcohols are just being explored, since they have been commercially available for only a short time.—*D. H. K.*

Polarized Light Inspection Instrument

POLARIZED light, about which so much has been written in recent months, has been given a new job—that of providing improved visual perception of colors, surface markings, weave, and so on, of various materials. Its particular value is in its elimination of glare and highlights so that true colors and true detail are made more clearly visible.

The Marks Polarized Colomat, the device

Polarized light shows true colors

that has been developed for such inspection and analysis, consists essentially of a case containng a suitable white light source and an optical system containing a Marks polarizing plate. Both the light and the binocular eyepieces are directed toward a partially enclosed large area through the sides of which the material to be examined may be inserted. This is shown in the accompanying illustration, the letter "A" indicating the space for the material.

There are many places in which this device may be used in both the laboratory and in the production line. With it one can inspect and match the color of textiles, prints, enameled articles; detect flaws, fine markings, strains and double refraction of materials; or examine textiles, fibers, powders, minerals, and metals.

"Mechanical Mole" Builds Ridge

A SIMPLE machine for building contour ridges on hillside pastures without destroying any sod—and at the same time leaving very little unsodded earth exposed -has been devised by Soil Conservation Service engineers in co-operation with engineers of Iowa State College.

Although farmers like the idea of the furrow-ridge because it conserves a rainfall on sloping pastures and reduces loss of soil, lime, and fertilizers by surface runoff, they have objected to the sod destroyed when the furrow is made with an ordinary plow.

The engineers call their furrowing machine a "mechanical mole" because it works mostly underground. A conventional rolling coulter makes a vertical cut about eight inches deep. A modified plow bottom, much like the old breaking plow of the prairies, lifts a sod strip eight inches thick on the downhill side of the coulter cut—but does not break the strip at the outer edge nor turn it over.

At the same time a plow bottom lifts a four-inch thick sod strip in a similar manner on the uphill side. A low, scraper-shaped plow, following directly behind this uphill plow, pushes about four inches of dirt into the eight-inch furrow under the downhill sod strip. All three plows and the coulter are attached to the same beam.

As the machine moves along, the four-inch uphill sod strip falls into place—but about four inches lower than before. The eight-inch downhill sod strip also falls into place—but four inches higher than before. The result is a vertical eight-inch wall or ridge; that is, a furrow about eight inches deep. This wall is the only soil left exposed to erosion by wind and rain—because the outer edges of the sod strips are not broken—and it soon becomes grass-covered. Height of the ridge may be varied by cutting the sod strips at different thicknesses.

Heavy rollers following behind the "mole" pack the sod strips firmly into place and leave the ridge uniform in height. The power needed to pull the mole varies with soil and slope, but apparently a track type tractor with about 20 drawbar horsepower is best suited.

The first work with the furrowing machine was done on slopes up to 10 percent. The furrows were on level contour lines spaced about 15 to 20 feet, with a vertical interval of about 1.2 feet. Some of the later work was on slopes as steep as 18 percent.

Widespread interest in the "mechanical mole" indicates that other machines of this kind may soon be developed. The "mole's" inventors are attempting to perfect a similar device which can be simply assembled from parts of ordinary farming equipment.

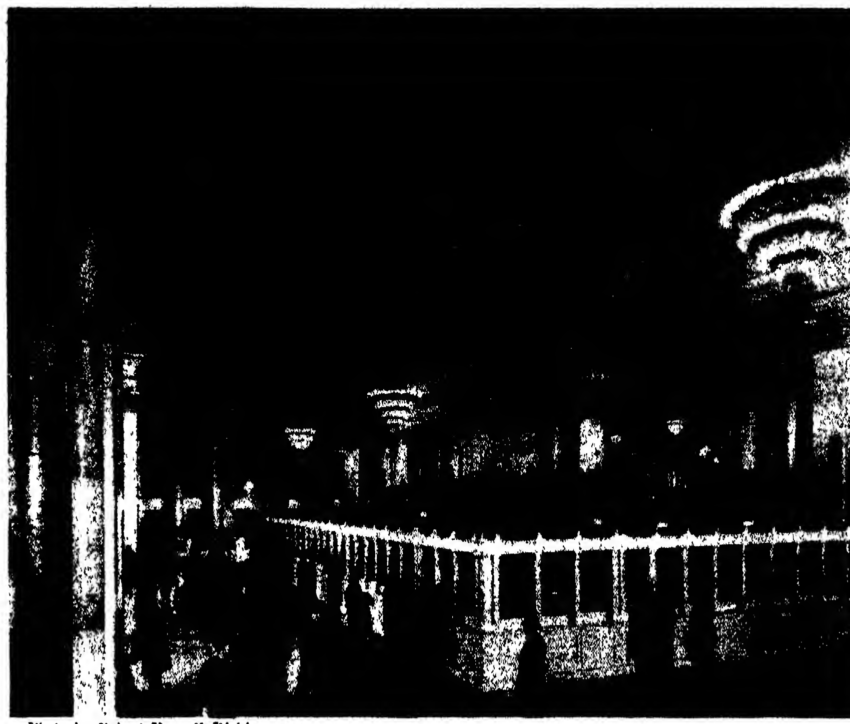
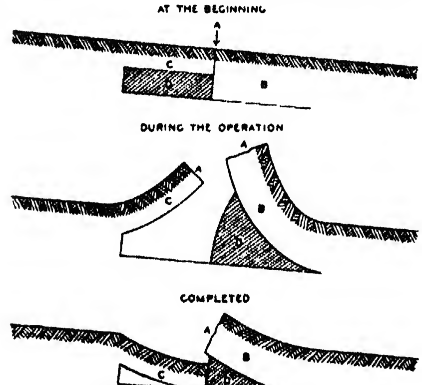


Photo by Robert Yarnall Richie

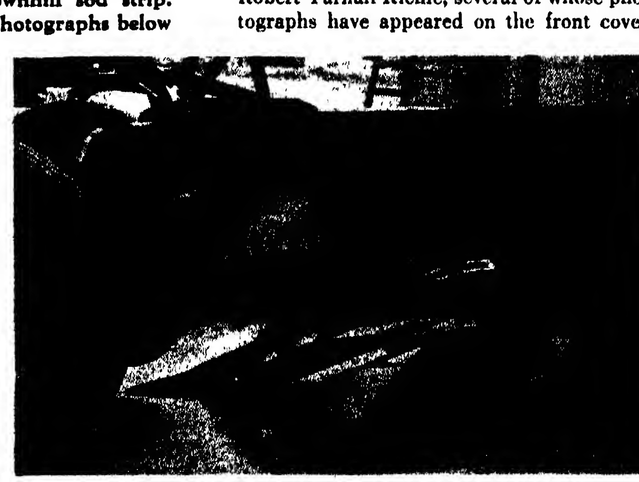
Correct lighting and a wide-angle lens made this photograph possible



How the mechanical mole works: *A*, vertical cut made by rolling coulter. *B*, sod strip on downhill side. *C*, sod strip on uphill side. *D*, soil thrown under downhill sod strip. See also the two photographs below

Photography on a Grand Scale

THE professional photographer of today frequently encounters situations that call for the proper execution of many and varied steps in order to produce the desired results. An assignment recently given to Robert Yarnall Richie, several of whose photographs have appeared on the front cover



Two views of the contour furrowing machine, showing plowshare with three lifters, and sod cutter with two lifters

of this magazine, required the production of a series of pictures that would tell the story of a great banking institution, the National City Bank of New York. One of the photographs desired, and one which called for the exercise of a considerable amount of ingenuity, was of the main room of the bank, which might be said to be the nerve center of the institution. The room, designed by McKim, Mead, and White, is 188 feet long, 125 feet wide, and 72 feet high. The photographer's job was to include as much as possible of the large room, showing officers, cashiers, tellers, guards, and customers. Thus there must be made a photograph that would show the great size of the room but which must include intricate detail, fine contrast in lights and shadows, and dramatic action. To achieve this result it was necessary to use 40 flash reflectors and 10 Photoflood units. The equipment set-up included cameras with wide-angle lenses, three of them being used, both to check error and offer a variety of composition. A telephone was installed on a specially constructed camera platform, and was connected through the main switchboard to all parts of the great room, so that proper instructions could be given to the 50 persons who were posed in various parts of the set-up. Five hours of hard work were required in the placement of lights and models before the actual taking of the picture.

Although the small size of our reproduction on the preceding page does not do full justice to the large original, the observing reader will fully appreciate the problems involved.

Sorts Spuds Automatically

FACED with the task of sorting by hand 15,000 bushels of potatoes into market grades every fall, a young Ohio farmer boy decided it was time someone gave serious thought to ways and means of simplifying this long and tedious job. After considerable experimenting, he conceived the idea of using a series of mechanical fingers made of bristles and mounted on pairs of disks. Each pair was set farther apart so that when the potatoes moved over the assembly they were automatically separated according to size.

If there were any skeptics among the people who came to view this machine, they went away convinced and the word soon spread about this new time- and labor-saving device. News of it reached a large farm machinery maker who sent its designing engineers to investigate. They, too, were convinced of its merits and arrangements were made with the youthful inventor to manufacture this potato grader for general use.

The manufacturer discovered, however, that while the mechanical fingers made of bristles worked satisfactorily for a time, they wore out and broke off quickly. The problem was submitted to The B. F. Goodrich Company, whose engineers soon developed for this machine fingers of a special wear-resisting rubber which not only graded the potatoes perfectly without injury, but cleaned them as well.

Scores of these new potato grading machines have been placed in service with highly satisfactory results. Operation is quite simple. Cleaning and grading is entirely automatic. The only manual labor required during the grading process is the removal by hand of those potatoes injured during digging and storage.

Rubber fingers sort spuds

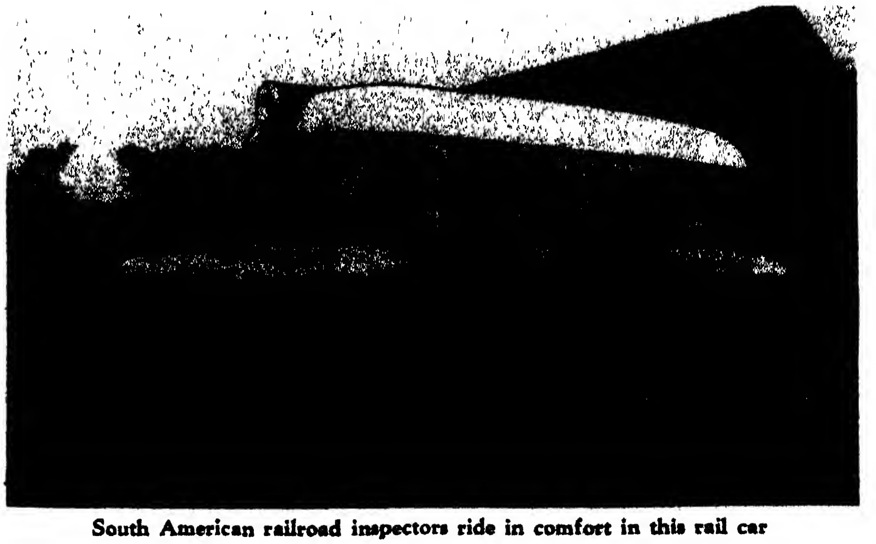
TRANSPORTATION SECTION

TIRES

IN 1910, an automobile tire costing 30 dollars produced 5000 miles; in 1936, a tire costing 15 dollars gave 20,000 miles—the estimated annual savings to American motorists due to research, 3,002,580,000 dollars.

Railroad Inspection in Comfort

STREAMLINED inspection cars like that shown in one of our illustrations are a familiar sight on many of the South American railroad networks. It was built by Grassi & Cia., Sao Paulo, Brazil, for the Estrade de Ferro de Goyaz of Brazil.



South American railroad inspectors ride in comfort in this rail car

Stretcher-levelled, cold-rolled steel sheets, 20 and 22 gage, manufactured by The American Rolling Mill Company, were used for all sheet metal parts on the car. It is powered by two automobile engines, placed fore and aft.

Officials of the line make frequent inspection tours in speed and comfort. The interior is furnished with six large armchairs.

Light Freight Trailer

APPLICATION of a self-aligning third wheel to the conventional two-wheel trailer chassis has led to the development of a commercial trailer or freight conveyor in which the entire load is carried by the trailer and none of it is thrown on the drawbar. The conveyor comprises a 16-foot van mounted on a steel chassis with carrying capacity of two tons. Because it is light in weight, it can be towed by a light delivery truck to supply a larger freight-carrying capacity than would be provided by the truck alone and yet obviate the necessity of maintaining heavy trucking equipment when the number of large loads is too small to warrant the investment.

A New Process in Rail Manufacture

RELAXATION, a recognized aid to human longevity, is now being utilized in the finishing of the inanimate railroad rail to give it longer life through increased resistance to the rigors of service in supporting the faster trains of today. This relaxation is brought about in the steel rail by the new "Brunorizing" process of the Carnegie-Illinois Steel Corporation, subsidiary of the United States Steel Corporation.

Like a tennis player, who, failing to relax, finds defeat staring him in the face, because his muscles grow tense, a rail may squander its strength by harboring teneseness in the form of dual internal stresses, one working against another. At the worst, these stresses can possibly cause microscopic internal discontinuities which one might call the "charley horses" of rails.

Relaxation in a rail is conducive to longer life because it delays fatigue, which may

ALEXANDER HAMILTON INSTITUTE

Announces

A NEW PLAN OF EXECUTIVE TRAINING

FOR sixteen months the Institute Staff has been working to prepare for this announcement. The results of its work make this one of the most important, perhaps *the* most important, announcement ever made by the Institute.

Important to whom?

Not to the *average* man, because he probably hasn't any more than a vague notion of what is going on in the world of business and doesn't care much about it either.

But to that smaller group of men who are the executives, and coming executives, in American business this message will be of utmost importance.

The next five years, even though they be years of prosperity, will prove a more severe test of personal and executive competence than any similar period in the past. Men who want to win financial independence must meet a new set of requirements. There will be none of the indiscriminate, get-rich-quick prosperity of the last boom. A higher order of business knowledge, executive training, and understanding of the new rules of industry will be the price of better-than-average income.

The Alexander Hamilton Institute is ready to prepare you for the test of ability and training which lies ahead. In each new business cycle during the past twenty-seven years, the Institute has developed and remodeled its Course and Service to meet the special needs of the day. Thousands of men have trained for executive responsibility and financial independence under the Institute's guidance.

Now again, the Institute, keeping abreast of American business developments, offers a NEW PLAN for executives and for those *who will be* executives—a plan built to meet the new conditions and to fit more exactly your personal requirements for growth and progress.

For Men Who Set No Limit on Their Futures
This Free Book Tells a Vital Story

IN this new plan of executive business training, the Institute offers you the ideas, experience, and judgment of the most successful business men in America, formulated and organized to put at your command the proved principles and methods of modern business.

Among the dozens of American industrial leaders who have helped to build the Institute's Course and Service are Alfred P. Sloan, President, General Motors Corp.; J. C. Penney, Chairman, J. C. Penney Co.; C. M. Chester, Chairman, General Foods Corp.; M. H. Aylesworth, Chairman of the Board, Radio-Keith-Orpheum; Clifton Slusser, Vice-President and Factory Manager, Goodyear Tire & Rubber Company; J. S. Tritle, Vice-President, Westinghouse Electric and Manufacturing Company; Hubert T. Parson, Director, F. W. Woolworth Co.; Frederick W. Pickard, Vice-President, E. I. du Pont de Nemours & Co., Inc.; Putnam D. McMillan, Vice-President and Director, General Mills, Inc.; Paul M. Mazur, General Partner, Lehman Brothers, New York Bankers; Thomas J. Watson, President, International Business Machines Corp.; David Sarnoff, President, Radio Corporation of America.

If you agree that daily access to the methods and judgment of such men will guide and inspire you, if you can appreciate the priceless opportunity of sharing their viewpoints and learning from their experience, then you will read "Forging Ahead in Business" with eagerness and profit. The new edition of this famous book carries a message of vital importance to you. The coupon will bring your free copy.

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Above: **A charge of rails emerging from the Brunorizing furnace where they have been subjected to a controlled thermal treatment.** ***Below:*** **The rail ends are given a Brinell hardness of 350 to 402 by means of a blast of compressed air**

ultimately result in a transverse fissure in the rail. In the "relaxed" rail the internal stresses are minimized so that a vastly smaller proportion of the total rail strength is accounted for by fruitless "pulling and pushing" within the rail and a high proportion of the strength is available to resist the fatigue of repeated loads under the wheels which exert veritable blows at the high train velocities. The specific degree of the reheating applied in "Brunorizing" relaxes the rail much as a rubdown and hot bath relaxes the athlete. But Brunorizing accomplishes even more.

A rail must be shaped from the great block of fine steel by rolling at a high temperature. At this temperature the steel is composed of many minute crystal grains held together with a tenacity even greater than the cohesion within the grains themselves. During cooling, a rail or any piece of steel must be cooler in the external outlying zones than in the interior. Furthermore, steel, like the mercury in a thermometer, expands with increasing temperature and contracts at lower temperature. Thus the difference in temperature in a cooling rail *tends* to produce different lengths and dimensions in accord with the distribution of temperature.

Now the strength of a rail prevents any such situation, but so strong are these tendencies that high stress is set up in prevailing against them and the attendant dimensional differences. These stresses reach a maximum when the rail has cooled well along toward ordinary natural temperatures. Brunner's method halts the cooling and stress building before it becomes serious and then the reheating equalizes the temperature again, wipes out the stresses, and starting from this new temperature some 300 or 400 degrees lower than the initial temperature the cooling never again builds them up to high values.

An equally important point relates to the size of the grain referred to above. The reheating establishes grains which are perhaps 20 to 50 times as small as the minute grains formed just after rolling, fine as they were! It happens that finer grains build up smaller stresses and dissipate those stresses more easily.

Car Design and Safety

IN a paper presented before the Society of Automotive Engineers, Mr. J. H. Hunt of General Motors discussed the important factors in the relation of car design and safety. The paper is too extensive to abstract here, but Mr. Hunt called attention to some governing conditions and features needing research, which may well be discussed.

Most car users do not realize that the design adopted must be a compromise between opposing conditions that affect safety. For example, lowering the center of gravity of the machine and lowering the top to reduce wind resistance contribute to safety under certain conditions, but the driver's eye has been lowered and the field of view in the immediate vicinity of the vehicle has been lessened. The designers think there has been a net gain but many drivers complain about the visibility, and the problem of deciding just what is the proper balance between such opposing factors is not easy to solve in the lack of pertinent accident data. It is to be hoped that in more investigations of highway accidents an attempt will be made to get the answers to such questions as this as well as to find the culprit upon whom the responsibility for the accident can be placed.

Headlights, horsepower, and steering gear ratios are other elements of design for which conflicting desiderates must be balanced.

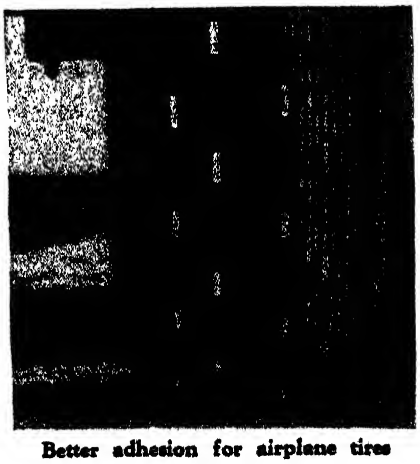
Although so-called safety glass is required by law in many states, according to Mr. Hunt, some surgeons claim that the percentage of fatal skull fractures is increased and that in severe collisions the damage done by its fine splinters is on the average worse than that done by the larger pieces of plate glass. Some fact finding is needed.

Mr. Hunt discusses the relation to design of fatigue factors such as ventilation, noise, vibration, eye strain, adjustability of the driver's seat, ease of control, and monotony, concluding with the following statement concerning the status of knowledge in this field:

"The problem (fatigue factors) is primarily one for the psychologist and the physiologist. The engineer can only remove or reduce sources of fatigue after information about fatigue sources has been supplied. We do not seem to have enough information about the effect of various combinations of annoyances upon people, even if some data are available as to the effect of simple disturbances, such as certain sounds and vibrations. Furthermore, the sensitivity of different individuals varies tremendously. A person who takes satisfaction in a smoothly operating mechanism may be greatly irritated by uneven running of the engine, while another person may be greatly distressed by a sustained engine noise, which would not disturb the mechanically minded person because this noise would seem to him quite in order. In the absence of scientifically proved data as to sources of trouble, we can only use common sense in attacking this problem, and are not justified in claiming too much for the results. We are justified in believing that the overall effects of the engineers' efforts in the last few years have been toward improvement."—*R. W. Crum.*

Non-Skid Cleats for Airplane Tires

SHARPENING the claws of the nation's fighting war-birds, the United States Army Air Corps has been experimenting at several of its air fields with steel cleats imbedded in the multi-vaned tread of the



Better adhesion for airplane tires

General streamline airplane tires with which many of the Air Corps' fighting planes are shod.

While the flexible rubber vanes of the squeegee tread on the low-pressure streamline tires provide maximum traction and adhesion to wet or dry runway surfaces, Air Corps engineers believed they might increase the clinging power of the tires on smooth ice if sharp steel cleats were imbedded in the tires so that they would bite into the smooth ice sometimes encountered in mid-winter landings. No tires have yet been devised which will provide sure traction on or adhesion to sheet ice, either on airplanes or on motor-cars.

Dots on Tires Indicate Balance

BY means of a system of dots placed on the sides of automobile tires, near the rim, manufacturers indicate how well the tires are balanced, and at what point with respect to the casing the inner tube valve should be placed when a tire is mounted. These dots, which may be square, round, triangular, single or in pairs, are red, and invariably are placed at the point on the casing where the inner tube valve should go.

There is no universal system of tire marking to indicate balance. Some tire manufacturers select their best balanced tires and mark them for front-wheel use, where balance is highly important. Tires that do not come quite to the front-wheel standard with respect to weight distribution are marked for rear-wheel use. Other manufacturers make no distinction, but produce tires that reach one definite standard of balance. Tires can be marked for front and rear wheel service only when they are shipped to automobile manufacturers as original equipment, with tubes in place in the casings and partly inflated. The complete unit—casing and tube—is balanced so that, when used on wheels that have themselves been balanced, the result is an almost perfectly running wheel assembly. Tires sold directly to motorcar owners are balanced, but, because there is no way of knowing the kind of inner tube that will be used with them, they are marked only for position of the valve stem.

Good Roads Make Bad Water

INCREASED use of tar on roads throughout the country is causing the water supplies of hundreds of cities to take on objectionable tastes and odors, reports the American Institute of Sanitation. Road tar contains small amounts of phenolic chemicals which are leached out by the rain and carried along to the lakes, rivers, and reservoirs from which cities obtain their water supplies.

The chemicals washed out from tarred roads by the rain are usually present in very small amounts and ordinarily are unnoticeable to the taste. But when the water is chlorinated the phenolic substances are turned into pungent compounds having a pronounced medicinal taste. Just a few drops of the phenolic leachings from tarred roads will render a million gallons of water undrinkable after chlorination. Since a majority of cities chlorinate their water to remove harmful bacteria, and since thousands of miles of roads in this country are

being tarred each year, the problem of medicinal tastes developing in water supplies is very common. Chlorination also emphasizes the various other disflavors in water caused by algae, industrial wastes, and so on.

Fortunately it is now possible to remove the objectionable tastes and odors in public water supplies that arise from tarred roads and other causes, says the institute. Scientists have perfected a purifier, activated carbon, which takes out such disflavors in water. Its action is mechanical, attracting and holding the undesirable tastes and odors. It does not dissolve in the water and adds nothing to it. More than 1000 cities in the United States are now using activated carbon to keep their water sparkling, sweet, and palatable, and the use of the substance is extending to Europe. The cost of safeguarding the palatability of a city's water supply is very small, amounting to only about three cents per capita per year.

(End of Transportation Section)

Nerve Transmission Both Electrical and Chemical

HOW the various portions of the body communicate with one another through the nerves, how the brain tells the finger to move or a pricked finger tells its plight to the brain—this problem is a major one in physiology. There are two general theories as to the method of communication or transmission in living material—electrical and chemical.

In recent years physiologists have accepted pretty generally the view that transmission along a nerve fiber is in the main an electrical phenomenon. Local currents within the fiber from the excited to the unexcited portion provide for the transmission of that state of excitation which we call a nerve impulse. But the transmission of a state of activity from one nerve fiber to another, as happens in the brain when any of our sense organs are stimulated, or from a nerve fiber to a muscle fiber, as happens when we make a voluntary movement, means the transmission of an excitation from one cell to another.

There is much discussion as to whether the passage over the junction point between the two cells is an electrical or a chemical process. There is much evidence to show that the transition is effected by chemical transmitters, such as acetyl choline, in the case of our voluntary and involuntary movements. According to this view, every movement we make is accompanied by the production of minute amounts of acetyl choline at the ends of the nerve fibers, and it is through this chemical agent that the muscle is set into action.

Other physiologists have held that the nerve impulse when it reaches the junction point is transmitted electrically to the muscle fiber.—Copyright, *Science Service.*

Self-Extinguishing Combustion

A KIND of combustion, flameless but otherwise like a fire, tends to extinguish itself as its temperature rises. In the search for a cheap method of making valuable chemical compounds for use in industry by oxidizing cheap raw materials with oxygen from the air (which costs noth-

ing), the reaction between acetaldehyde and air to form acetic acid in the presence of a catalyst has been found to go slower as the temperature rises.

Normally, when organic materials are oxidized (that is, burned) in air, the products are carbon dioxide and water, and the hotter the fire gets the faster it burns. The reason for this is that oxygen more readily combines with carbon and hydrogen as the temperature goes up. However, when a mixture of the vapors of acetaldehyde and air is passed over a heated catalyst, acetic acid is formed directly. This conversion takes place more rapidly as the temperature goes up until it reaches the range of 145 to 160 degrees, Centigrade. After passing that temperature, the rate at which acetic acid is formed drops. The catalyst used is a silica aerogel containing a small fraction of 1 percent of platinum oxide. The explanation of this slowing down of reaction, offered by Foster and Keyes of the University of Illinois, who have investigated it, is that at the optimum temperature, contact between air, catalyst, and acetaldehyde is best and that above this temperature the contact between the three essentials to the reaction is less intimate.—*D. H. K.*

INJURY

HIGH-SCHOOL chemistry books and courses should be revised to increase instruction on how to prevent and treat injuries of a chemical nature, according to Dr. J. O. Frank, head of the Department of Chemistry of the Wisconsin State Teachers College.

Modeling Sheet Resembles Leather

A NEW material which looks and feels like leather and which may be tooled in beautiful designs has just been announced by the Arts and Crafts Division of the Burgess Battery Company. This interesting new art material, Cellocraft, is easy to work and requires little skill or effort. Worked according to directions, it gives results resembling those obtained with the finest Russian tooling calf.

Cellocraft is a tough fiber board with a velvety leather-like surface available in two

Made of leather-like Cellocraft

Touching up a design on Cellocraft

colors—chrome and brown. After tooling, it may be colored with water colors, wax crayon, oil, dyes, stain, or wood finish, and then varnished or lacquered.

The process of tooling is quite simple. First, a design is traced with a stylus in the front side of the sheet. Then the back is carefully dampened and the stylus is used to press the design through from the back while the work is held in the hands.

Utilizing Oat Hulls

By treating oat hulls with dilute acids, a solution containing sugars is produced. Recent investigations have shown that when this product of oat hulls is added to corn mash, a good yield of butyl alcohol, acetone, and ethyl alcohol can be obtained by fermentation. Oat hulls have been studied as typical of farm wastes containing cellulose. The preparation from them of valuable solvents like butyl alcohol and acetone indicates a possible method of utilizing agricultural wastes to produce industrial raw materials.—*D. H. K.*

A Dusty Discourse

Announcement of another possible solution of the silicosis problem (see article on page 26 of this issue) has been made in a medical report by scientists and physicians at the University of Toronto, who suggest that tiny traces of aluminum dust added to the silica-filled air breathed by workers may eventually stay the ravages of silicosis. These investigators were able to prevent silicosis in the case of rabbits that breathed silica-filled air containing a trace of aluminum powder, while rabbits that breathed the silica dust alone contracted silicosis. From this work, it has been concluded that the presence of the aluminum in the dangerous dust inhibits the rapid solution and concentration of the silicious material, thereby preventing degeneration of the lung cells and the production of fibrous tissue.

Other research workers, reporting in the *American Mineralogist*, intimate that dusts like powdered coal, iron oxide, and alkaline earth carbonates also have a protective ac-

(*Please turn to page* 44)

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

OF all the things optical described in the book "Amateur Telescope Making—Advanced," published last February and now owned by just under 2000 amateurs, the Richest-Field Telescope or "RFT" has perhaps attracted the most attention. This is a short-focus, wide-field reflector of high light-gathering power, that is simply held in the arms and used for exploring the starry reaches of the galaxy. It is designed to reveal at one view of striking splendor

Figure 1: Myers and his RFT

the greatest number of stars possibly visible at one time. A thoughtful person cannot help but feel deeply impressed when he thus sees with his own eyes what an inconceivably vast and magnificent thing our universe is. S. L. Walkden, father of the scientifically designed RFT and author of the RFT chapter in ATMA, was right when he said that it made the awed beholder almost wish he were alone with his telescope.

Figure 1 shows J. E. Myers, 1519 Olin Ave., Omaha, Neb., holding a 5⅝", $f/4$ RFT. Figure 2 is a photograph of Frank Wickenburg, Theosophical Headquarters, Point Loma, Calif., with a 5", $f/4$ RFT which gives a full 2° field. "It is packed full of thrills," he says, "and at a recent meeting of our club in San Diego it stole the show." Figure 3 is a 4", $f/3.4$ RFT made by George R. Harrington, Jr., 4031 Vernon Road, Drexel Hill, Pa. He writes: "It astonishes me what this scope picks up —I'll give Mr. Walkden a vote of thanks." Figure 4 is from Willard R. Harer, 311 Rodman Ave., Jenkintown, Pa., who says, "The results with it are highly gratifying, giving me the most beautiful sights I've ever seen with a telescope. It surpassed my expectations."

The remainder of the account is by Mr. Walkden, and the reader will discover that the chapter in ATMA merely scratched the surface of this subject. Whenever the abbreviation RRFT is used, this means "richest, richest-field telescope," a sort of superlative superlative, if this is possible.

"ADOPTING the accessible data it becomes evident that, if the observer uses an 11th-magnitude RFT, perhaps of about 2¾" aperture, he may obtain the most star-crowded average field of view with respect to the zone of the Milky Way all round the sky; on which account such an RFT had better be distinguished as the general-purpose RRFT, and, though small, be regarded as the most important instrument (Figure 5).

"Suppose, then, that instrument is directed upon an average star-cloud at average distance of about 3000 light-years, upon which cloud the RFT is acting as the proper RRFT because of just revealing that critical star, here of the 11th magnitude, at which the stars of the cloud stop increasing in numbers faster than they grow fainter. (ATMA, pages 631-633). Now let the aperture be made x times greater. Of course the aperture area is x^2 times greater, and so it can reveal the critical star if x^2 times as faint. That will occur if the whole star-cloud and its critical star is placed x times farther away. Any doubt as to whether the critical star remains the same individual star may be easily dispelled, on realizing that distance fades all the stars similarly, without altering the relative brightness of one star compared with another. (Each cloud is supposed to have only a moderate depth, compared with its distance.)

"Now the ability just to reveal the critical star exactly defines the RRFT condition, and so it comes about that an RFT of *any* aperture $2\frac{3}{4}x$ inches can become a special-region RRFT on our finding for it a star-cloud at distance $3000x$ light-years. Since $3000x-2\frac{3}{4}x$ is practically 1000, we may say that *every RFT can become a special-region RRFT for a star-cloud distant about 1000 light-years per inch of aperture.* The rate of proportionality, 1000 light-years per inch of aperture, will be further justified, later, on the basis of what the critical star really is.

"Then there is the question of the numbers of stars in the fields of view. As in the third line of page 637, ATMA, the rule for the number of stars seen in the field of a standard RFT is

$$N=102.6\times\Delta/a^2$$

(The final term of this equation was misprinted in ATMA with $\Delta m/a$. The 102.6 is the square degrees area of the actual field of view of a standard 1" RFT of 40° apparent field diameter; so the $102.6/a^2$ is the square degrees area of the actual field of a standard RFT of a" aperture. Finally, of course, the multiplication by Δ at once finds N which for the general-purpose, 2¾", RRFT becomes

$$N=102.6\times25.4/2.75^2=345 \text{ stars,}$$

as stated on page 636, ATMA.

"When, now, the star-cloud is pushed x times farther away, and is followed up by the x times larger aperture, so that the aperture becomes $2\frac{3}{4}x$ inches and the star-density becomes, by a natural perspective effect, $25.4x^2$, then

$$N=102.6\times25.4\times x^2/(2.75\times x)^2$$
$$=102.6\times25.4/2.75^2=345 \text{ stars,}$$

precisely as at first, aperture and distance having had no effect whatever.

"Yet it is the case that the larger sizes of instruments do offer opportunities for showing much more star-crowded fields of view, and there are reasons for this being so. If, while looking at an average cloud at the average distance, we turned to another cloud at the same distance, and found it gave a field of view b times more crowded, we should have to conclude this second cloud had b times the Δ of the first, in fact a star-density of $25.4b$. But, looking at the cloud even with the naked eye, we should notice it also had b times the surface brightness or shine of the first cloud, because there would be b times as many stars per square degree to help the surface brightness or shine. Thus b, the brightness or shine compared with the average, becomes an exact measure of the Δ of the cloud for a view at the average distance. The shine of the cloud is not affected by distance, for while at x times the distance the stars are all faded x^2 times there are, to compensate, x^2 times as many stars per square degree acting to make the shine. Accordingly, a brightness or shine of a cloud b times the average tells us the cloud has a star-density, at

Figure 2: Wickenburg and RFT

average distance, of $25.4b$, so that if the cloud is actually at x times the average distance then, by the rule,

$$N=102.6\times25.4b\times x^2/(2.75x)^2=345b$$

stars.

"This all becomes very simple; it enjoins looking at the star-clouds which are distant as many thousand light-years as there are inches in the RFT aperture used, and then preferring the brightest of these clouds.

"But the problem is to know the distances. What can usually be done is to judge on the basis of results or experience. The nearer clouds, such as the Cygnus clouds,

are recognizable by soon resolving into stars on a darkening background, even with quite small RFT apertures: but the farther and farther clouds want larger and larger RFT apertures, before a decidedly stellar field replaces the powdery appearance and there is a substantial darkening of the milky luminous background.

"*(Note:* So far as the star-clouds contain the Eddingtonian kind of stellar mixture to

Figure 3: **Harrington and RFT**

be referred to later on, the following method can estimate by calculation, and closely enough, the RRFT aperture required for a simple spot of cloud. First, look at the cloud through a refracting test telescope of T'' aperture, of low power though not necessarily as low as an RFT, and count the stars in the field of view. Then cut down the aperture to 60 percent of the full diameter, by a cardboard stop, and again count the stars, and find the quotient, Q, of the first number of stars divided by the second. The RRFT aperture needed is then simply about $Q^3 \times T/25$ inches diameter, so long as Q is kept within the limits of 5 and 2 by the use of a suitable size of test aperture, T''. A 3″ will be found to test up to 15″ aperture, a 4″ up to 20″ aperture, and so on in proportion. The quotient Q is always about $\sqrt[3]{25}$, or 2.9, when the telescope in use is already the proper RRFT; and so far as the cloud is distant 1000 light-years per inch of RRFT aperture the method also estimates *the distance of the star-cloud.* The *reflector* RRFT has generally to be of about 50 percent larger aperture, and it may show about 25 percent smaller number of stars. The method is based on our knowing how far we are from the peak of a known arched curve, as soon as the slope near where we are now has been made to reveal itself.)

"However, it is clear why the larger apertures can show more crowded fields. A small 2″ RFT acting as an RRFT performs upon star-clouds distant only about 2000 light-years, and such clouds are few to select from and not particularly bright ones. Perhaps 300 stars may be expected. But a 20″ RFT acting as an RRFT performs upon clouds distant about 20,000 light-years, where there are a hundred times as many to select from (chiefly a surface matter, depending quite on the square of the distance), and several really very bright specimens. Where $b = 6$, $N = 345 \times 6$, and

about 2000 stars may be expected in the field of view.

"(*Note:* Since the actual field of a special-region RRFT is $11.43/a$ degrees in diameter, and 1° at 1000 light-years is 17.5 light-years, and since the distance at which the instrument operates is about $1000a$ light-years, the actual field of view is, very curiously, always about $(17.5/1000) \times 1000a \times 11.43/a$, or 200 light-years diameter in the proper star-cloud. A tube of 100 light-years radius and of D light-years depth is of volume $\pi \times 100^2 \times D$, cubic light-years, which is the *volume* of the field in the star-cloud. If S is the number of stars per million cubic light-years of the cloud (down to the critical star), then the number of stars in the field is the volume $\times S \div 1{,}000{,}000$, and that is to say that $N = 0.0314 \times D \times S$. This alternative formula for N is of little more use than again to advise finding deep and congested clouds to operate on with the proper apertures—the clouds distant and bright, like those about 30,000 light-years away near the hub of the galaxy and needing apertures of about 30" for their RRFT's. The special-region RRFT for a particular star-cloud is, by the way, very agreeably more sharply defined than is the general-purpose RRFT designed for the whole round of the Milky Way, for reasons of a kind not very hard to perceive.)

"*Practical Applications:* In the application of what has been explained, a 1" RFT could be a special-region RRFT if the nearest clouds in Cygnus were at half their

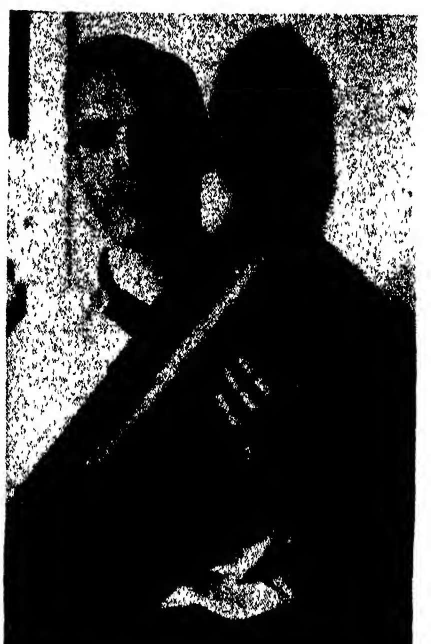


Figure 4: Harer and his RFT

distance of 2000 light-years, to bring their critical star within the grasp of so small an aperture. But, used upon those clouds as they are, there may be seen about 200 stars in the field of view, and though not very bright the view is recommended as quite cheerful for so tiny an instrument. A 2" can really start being a special-region RRFT upon those clouds of Cygnus, exhibiting bright and charming views of about 300 stars. The important 3" RFT is a special-region RRFT for the further clouds of Cygnus, as well as being the general-purpose RRFT for the whole Milky Way, as several times explained. It shows about 350 stars per average view. The 6" RFT, as the special-region RRFT for the 6000 light-year, nearer clouds of Scorpio, is able to select brighter clouds, and 600 or 700 stars per view may be expected (probably parallelled by the special-region, rich-field observations described by Mr. Tombaugh on page 640, ATMA).

"The 12" and larger are special-region instruments for the big clouds near the hub of our galaxy, in Scorpio and Sagittarius, and have much bright material from which to select. Fields quite as rich as 1000 or 2000 stars may be found in places, and appear very magnificent. A 100" RFT, which should be the proper special-region RRFT for the Greater Magellanic Cloud, which is very bright in places, may be expected to produce superbly magnificent fields of view of surpassing grandeur, containing thousands, perhaps nearly 10,000 stars, with several, perhaps, as bright-looking as Sirius, and one or two, perhaps, as bright-looking as Venus or even brighter—much brighter if a naked-eye foreground star can be caught in the view.

"*The Real Critical Star:* Turning to the sublime meaning of these views, few users of the RFT's as regional RRFT's are likely ever to forget that these marshalled hosts of heaven, delicately colored like sparkling jewels, from red to blue, and drifting across like snow at every move of the telescope, are really the magnificent suns of our universe. Estimates have been made of the relative numbers of stars of different sun-powers in an average sample of the stellar mixture that seems to prevail everywhere in space. One estimate is in Vol. 21, page 320, of the 14th or latest edition of the *Encyclopædia Britannica* (Sir Arthur Eddington's article on Stars). For every 200,000 stars of the same power as our own sun, there are said to be 42,000 ten times as powerful, 3300 one-hundred times as powerful, 90 one thousand times as powerful, and one ten thousand times as powerful, and of course there are vaster multitudes less powerful than our sun, all of which, strangely enough, we shall not have to regard. The important thing is that, when these figures are examined by means of a curve on squared paper (a curve of the numbers of stars, 1, 91, 3391, 45,391, and 245,391 against the sun-powers, 10,000, 1000, 100, 10, and 1; preferably done on double logarithmic paper or by plotting logs both ways on plain squared paper, carefully noticing the point of 45° slope), it is found to be at about sun-power 15 that the stars stop increasing in number faster than they grow fainter. Of course, this tells us what our critical star really is at close quarters. It is really a sun of about 15 times the power of our own splendid sun, and other disclosures easily ensue. Since the special-region size of RRFT is determined by just perceiving the critical star and none fainter, it astonishingly follows that these gloriously rich fields are made up of stars all more than 15 times as powerful as our sun. Indeed, if all the stars less powerful than that were blotted out of existence the fields might look still finer, gaining by contrast with a darker background between the lucid countable stars. Other facts emerging are that the average power of those stars in the field of view must be about 27 times the power of our sun, and out of every 350 stars in the fields there is one likely to be

over 1000 times as powerful as our sun. Of course there are stray stars between us and the star-cloud, and some of these within one quarter of the distance of the cloud—the square root of 15 is about 4—may be no more powerful than our sun, but they are only a casual few, and not in the cloud.

"Our own sun, we know, looks like a 10th-magnitude star at 326 light-years distance. Therefore, it would look 2.512 times

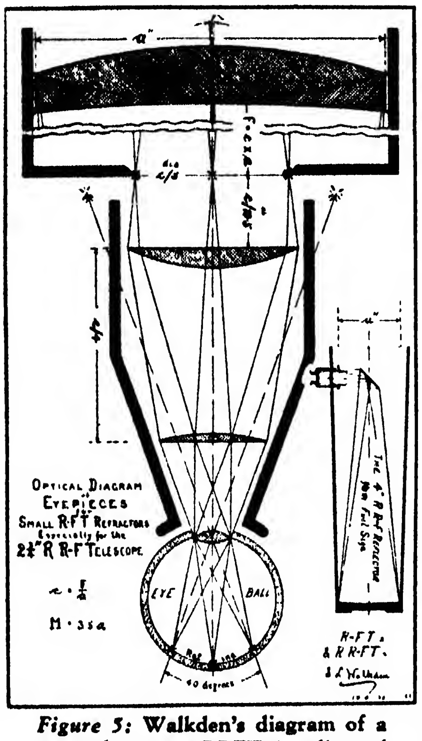


Figure 5: **Walkden's diagram of a general-purpose RRFT (to clip and insert at page 636, ATMA). Angle marked by little arrow at top is 11.43/*a* degrees. This indicates the actual diameter of the visible field**

brighter and of the 9th magnitude at $326/\sqrt{2.512}$, or 206 light-years distance. So the critical star of 15 sun-power would also looks like a 9th magnitude star—which is supposed just perceivable with 1" of aperture—at $206 \times \sqrt{15}$, or 797 light-years distance. This—with some disrespect for exactness of the data or respect for better eyesights—is going to be rounded off to about 1000 light-years for each inch of aperture. And so we find confirmed the rule, easy to remember and already used in the earlier part, that *an RFT proves to be an RRFT, for star-clouds distant about 1000 light-years per inch of aperture.*

"There is, accordingly, good reason for an observer having not only the little general-purpose RRFT, but another of as large an aperture as he finds possible, this second one for use on to-be-discovered special regions of the Milky Way and giving views magnificent according to the aperture. The observer need not first ascertain the cloud distances—small star magnitudes and the powderiness of the fields can suggest the distances—he only needs to discover and exult in the brightest and richest spots, which he knows are findable here and there.

"*The Special-Object RRFT:* The possessor of an RFT soon notices the vivid views it gives of some objects which are not definitely star-clouds. Since a standard RFT has an actual field of about 11.43/*a* degrees in diameter (see footnote, page 633), it always

performs splendidly on objects which look their best in fields of about 12/*a* degrees diameter, or, with reasonable latitude, in fields from about 18/*a* to 8/*a* degrees diameter. In this way a 2", with field of about 6° diameter, may be found to be a *special-object* RRFT for viewing the bright groupings in the prominent constellations of Orion, Taurus, Cygnus and many others. A 4" is still more delightful in the same way, and for viewing the Hyades and Pleiades and open clusters, and especially for most beautifully viewing the Andromeda Nebula *as a complete whole.* A 12" gives most dazzling (perhaps too dazzling) views of the moon, three-quarters filling the field when a power of 5 per inch of aperture is used; the bright light contracts the eye's pupil to about 1/5th inch. A 24", of field about half a degree, takes its place for viewing most brilliantly the globular clusters, especially the great Hercules Cluster; but it also gives a remarkable view of the whole spread of Jupiter and his satellites, the latter looking like first-magnitude stars. It is as well in these instruments to have spare eyepieces of about ¾, 2, and 3 times the strict richest magnifying power, to help some objects to occupy the apparent field in the best possible manner, since a separate RFT for each of the many sizes of objects is rather out of the question.

"*The Spiral-Nebulae RRFT:* Just as the 4" RFT is found to be about the best size for observing the Andromeda Nebula as a whole, so also would the 8", 12", 16", etc., RFT's be the best sizes for observing the same nebula if it went away to 2, 3, 4, etc., times its present distance of about 1,000,000 light-years, for of course, the nebula would shrink to ½, ⅓, ¼, etc., of its present apparent size, by such recessions. Evidently an RFT suits the observation of such spiral nebulae at a distance of about 1,000,000 light-years for each four inches of its aperture. The number of nebulae so observable, each in its entirety and nicely filling the field, must, of course, be roughly proportional to the square of the distance, and that means to the square of the aperture. The great 200" therefore, if completed as a *visual* RFT, would show a few thousand nebulae, just as the one in Andromeda appears so beautifully in the field of a 4" RFT. For the tens of thousands of such nebulae much nearer, the 200" is too large to show more of each one than a small patch, which, however, in the case of the Andromeda itself, may be richly filled with 1000 or more of stars, each one at least 400 times as powerful as our sun, and these seen against the irresolvable luminous haze of all the rest."

THIS ends Mr. Walkden's contribution on the RRFTs for various special uses, and the reader will have observed that, just as the common or garden variety of RFT enhanced the view many times, compared with a conventional telescope, so the special-purpose RRFTs, used on their appropriate objects, enhance even this a goodly number of times. Every amateur has had the experience of showing the stars to non-astronomical persons and slyly noting their disappointment at not seeing something quite striking; they go away thinking their telescope-making friend "isn't so much, after all." If, however, they are shown some RRFT views, they may go away vastly impressed.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 39)

tion and assist the lungs in their elimination of dust so that no permanent damage occurs.

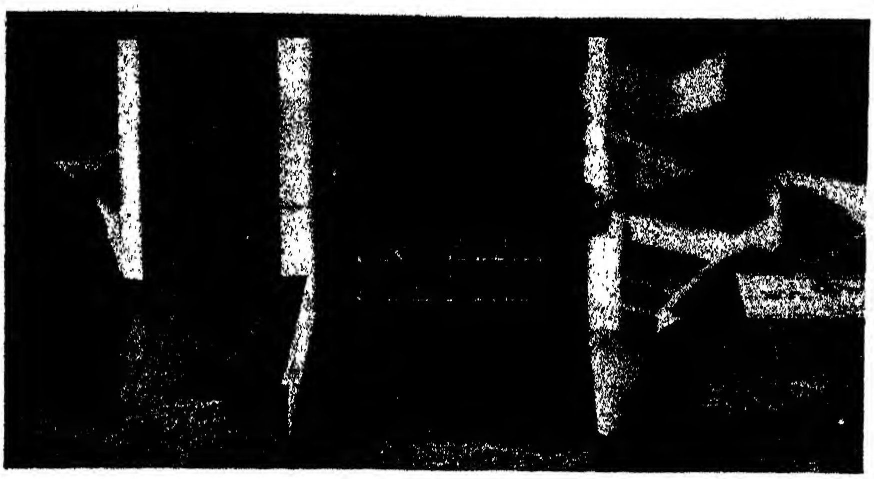
Silicosis is known by a wide variety of names, such as "miner's consumption," "potter's asthma," or "grinder's rot," according to the occupation in which it is caused, but in all cases it is a disease due to the inhalation of silica dust. It is characterized anatomically by generalized fibrotic changes, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, increased susceptibility to tuberculosis, and by characteristic X-ray findings. While possibly not the worst American health hazard, silicosis will continue to be dangerous as long as there are unprotected workers in dusty occupations.

Industrial engineering research has played an important part in detecting silicosis hazards, and special equipment and methods have been devised to indicate the amount, size, and kind of dust particles found in industrial situations. The Greenburg-Smith impinger, which has been used for determining the total number of dust particles in large volumes of air, functions by causing the dust-laden air to bubble through water and impinge upon a moist plate which wets the dust particles and keeps them in suspension. Portions of the liquid are then examined microscopically with the use of a specially ruled dust-counting cell, which gives an indication of the number and size distribution of the dust particles present. Typical of a more recent development is the Bausch & Lomb dust counter, which unites in a single mechanism the pump for impinging the dust samples upon a moist plate and a semi-dark field microscope for viewing the dust particles when they are obtained. Instruments of this sort have the advantages of speed and compactness, although they sample much smaller quantities of air.

A still more recent development is found in the Dustoscope, an instrument for the estimation of dust in air, which was developed by J. B. Ficklen and L. L. Goolden, chemical engineers, of the Travelers Insurance Company. This instrument has the advantage that neither microscope nor laboratory apparatus is necessary, and a layman can make satisfactory estimates for control of plant dust. Further methods for determining dust hazards have been developed by workers at the Aetna and the Liberty Mutual Insurance Companies who have worked on the determination of the chemical composition of very small dust particles by observing their optical characteristics with the polarizing microscope.

Among the best known methods for the prevention of silicosis are segregation of dust-producing operations, dust control, ventilation, protective devices, good housekeeping, and medical supervision, including periodical X-ray examinations of the chest.

At a recent Department of Labor conference on silicosis, it was agreed that there should be coverage for silicosis in the compensation acts of all the states, and it was further recommended that the federal legislation provide more adequate appropriations



to government agencies for the study of the medical, engineering, economic, legal, and insurance phases of the silicosis problem. Research projects suggested to aid industry in its conquest of the disease include a study of the relationship between silicosis and tuberculosis, the effects of other substances upon the action of silica in the body, a study of the mechanism by which silica exerts its injurious effects, and research in the technique of X-ray photography—*Industrial Bulletin* of Arthur D. Little, Inc.

Sweets, Starches, and Colds

YOU may have fewer colds this winter if you cut down on sugars and starches in your daily diet, it appears from a report made by Frederick Hoelzel of the University of Chicago to the scientific journal, *Science*.

Observations by himself and various other investigators show that colds are fewer on such a diet and Mr. Hoelzel believes it is because the diet reduces the amount of fluid in the body tissues and this in turn reduces susceptibility to nose and throat infections.

If you think of applying this theory, it would be advisable to have the diet prescribed in detail by a physician so as not to run the danger of becoming ill from a badly balanced or deficient diet.—*Science Service*.

Dam Holds out Backwater

THE first major flood prevention project to reach the construction stage in the Pittsburgh district will protect the Turtle Creek valley in which lies the huge works of the Westinghouse Electric and Manufacturing Company and other major industries.

In the future when high water from the Monongahela River threatens the valley, two huge gates will be lowered, forming a barrier against rising waters and the normal flow of Turtle Creek will be continued by means of powerful pumps. The project will cost 500,000 dollars.

Installation of the gates will be made near the viaduct where the main tracks of the Pennsylvania Railroad cross Braddock Avenue and the creek just below the main works of the Westinghouse Electric and Manufacturing Company. One of the steel gates, 90 feet long by 30 feet high, will form a dam in Turtle Creek; the other, 40 feet long and 20 feet high will close the

***Above:* A model of the huge gates that will hold out the backwater of the Monongahela River. *Below:* Arrow on model points to the dam that will soon isolate Turtle Creek**

street. When not in use the gates will be held approximately 20 feet above the street level to accommodate traffic.

The three pumps to be installed will have a combined capacity of 7500 cubic feet a second or more than 3,300,000 gallons a minute, when pumping against a low difference in height between the level of the creek and the level of water beyond the gates; and a capacity of 5000 cubic feet per second when pumping against a difference of 10 feet in the two levels.

NICKEL-CARS

THE automobile industry in the United States used 19,000,000 pounds of nickel in 1936.

Man-Made Stone, Unique Building Material

STONE melted under intense heat and then cooled in a porous state is the basic material in the manufacture of a new acoustical building material recently developed in the laboratories of The Celotex Corporation. Brought to the boiling point at a temperature of more than 2000 degrees, Fahrenheit, this expanded stone, christened

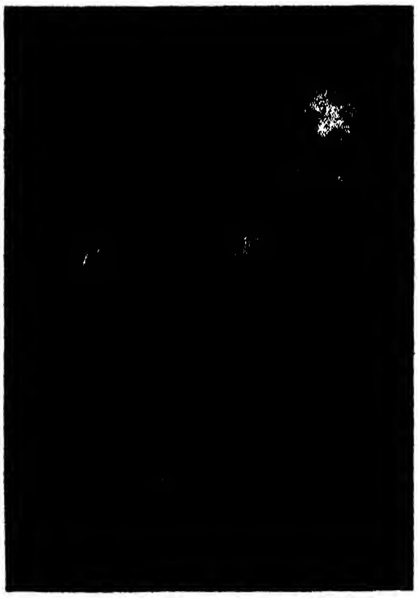
(*Please turn to page* 52)

CAMERA ANGLES

Conducted by JACOB DESCHIN

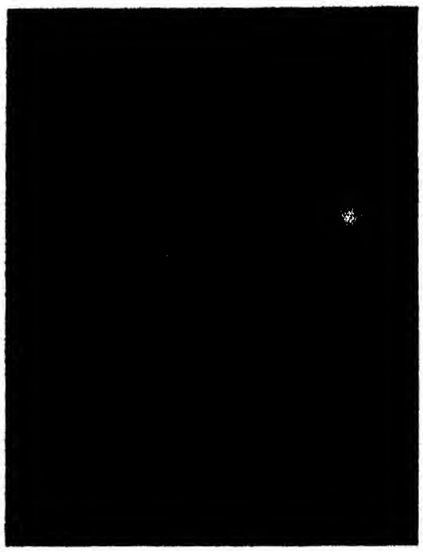
Pictures at Night

THE fascination of pictures made at night has currently become associated chiefly with the miniature camera and fast lenses, candid shots and snapshots of street scenes, and so on. However, night pictures were made before the miniature came upon the scene simply by setting the camera firmly on a tripod and giving a time exposure. And when it comes to that, the best night pictures are made that way even today, with time exposures and often with the lens diaphragm stopped down. Nor is it especially necessary, unless one is making a snapshot (where this is possible with the fastest panchromatic emulsions today available or where some movement in the subject demands it), to employ ultra fast film. Film of average speed is quite suitable; you simply allow a little more exposure.



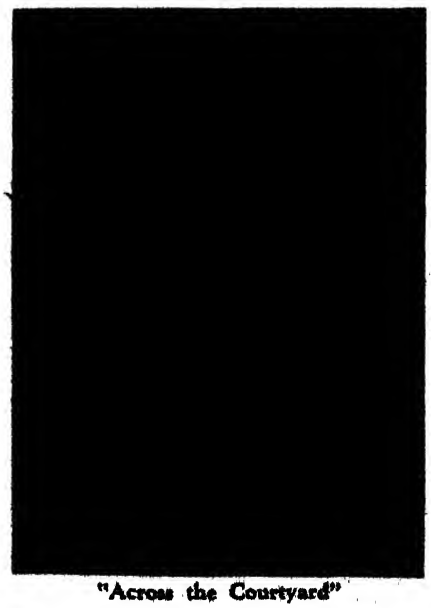
"By Moonlight"

Since the type of subject we have in mind will stand a small stop and a time exposure, the stopping down of the lens diaphragm is equivalent to reducing the speed of the lens. That makes the so-called cheap, "slow" lens in many cases the equal of the faster lenses when stopped down. So you fellows who have been entertaining an inferiority complex because you cannot at present afford to purchase one of those shiny, new fast-lens cameras may rest secure that, given an even break, such as small-stop night photography permits, you can turn out work every whit as good as that produced by the much more expensive camera equipped with a high speed lens, whose high speed—that is, the largest diaphragm opening of which the lens is capable—is for the time being in temporary suspension, being as slow a lens when stopped down to F:6.3, for example, as a regular F:6.3 lens which has no larger opening.



"Winter Night"

While the picture "By Moonlight" was made at the full opening of an F:3.5 lens, a faster film emulsion would have permitted the use of a slower lens or smaller stop. The exposure, too, had to be relatively short because of the movement of the moon. The exposure, incidentally, was 30 seconds since this, as you may recall from a piece appear-



"Across the Courtyard"

"The City at Night"

ing in this department some months back, is the maximum permissible time exposure for "stopping" the moon. Clouds usually proceed too rapidly to be stopped at 30 seconds, but the slight fuzziness noticeable helps rather than mars the effect.

"Winter Night" is another miniature camera shot made at F:8 and an exposure of several minutes. The picture was made through an open window on the opposite side of the street and called for frequent capping of the lens as the headlights of automobiles streaked across the scene.

"Across the Courtyard" and "The City at Night" were exposed on 9 by 12-cm film, the first calling for an exposure of 12 minutes, the second requiring 15 minutes. "Across the Courtyard" was made with a telephoto lens that reached out across a space more than half a city block long to get an impression of domesticity in a city "cliff" dwelling. Notice how small, intimate details have been picked up by the lens, stopped down to F:8. The camera was set askew on the tripod to get the effect shown, since the ordinary vertical viewpoint seemed to possess no special attraction. The reader will please be charitable enough to overlook, if he happens to notice it, the fact that the legs of the lady in the room at the top seemed to go double during the exposure. It is just one of those things that can't be helped when human beings are included in such a long exposure as 12 minutes; besides, we were photographing windows, not a lady's legs.

"The City at Night" was shot from the back part of the house. A lens of normal focal length was used and the diaphragm stop was set at F:8. Since the window through which the shot was made was of the casement type, obstructing the view at the sides, it was necessary to set one leg of the tripod on the outside window ledge. Such dodges as this will frequently have to be used by the amateur who attempts night photography, where unforseen obstacles beset the path and ingenuity has to be exercised to overcome them.

The illustrations here shown indicate to some extent the type of material it is possible to shoot at night with even the cheapest cameras and call attention once again to the fact that night photography is still, as it always will be, within the means of other photographers than the high-speed clan.

Fotofolio Files

REPLACING the ornate, heavy album of yesterday is the Fotofolio idea of today, a new method of filing negatives and prints. An adaptation of the business method of keeping card index records on overlapping cards held by hinges, the Fotofolio albums will take 25 prints to the page and, in some of the styles, negatives of the prints as well. Thus, print and negative are kept together for ready availability. The albums are designed in book form and finished in cloth, "neo-leather," and full leather. Gold lettering is furnished on brown, green, red or black. The Fotofolios are available in various styles, taking negatives from 35 mm up to the larger size amateur snapshots.

International Salon of Photography

SOME indication of the mortality rate of a great salon will be gained from an examination of the results of the judging of the Oval Table Society's International Salon of Photography, recently held in New York City. However, though many fell by the wayside, those who succeeded in getting hung may truly be said to have "arrived," for the judging was most critical and the standards very high. Prints were received from all over the world; there was a total of 3155 prints in both pictorial and technical sections, of which 2968 were pictorial and 187 were technical. Only 443 prints, or about 15 percent of the pictorial total, made the grade, while the technical prints fared better with 125 accepted out of a total of 187 submitted, the percentage in the latter case being 67. Successful exhibitors in the pictorial section totaled 291 out of 775 entrants, a percentage of 38 and those success-

ful in the technical section were 74 out of a total of 136, a percentage of 55.

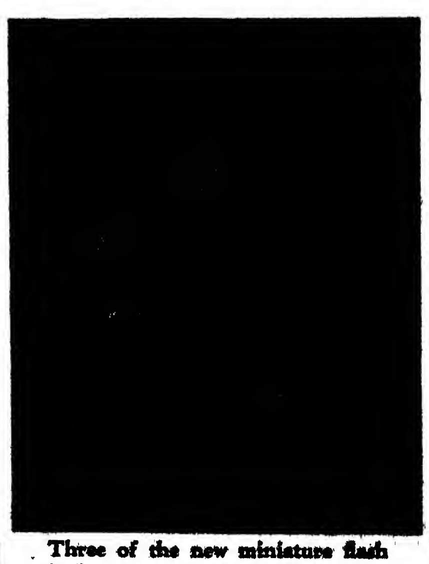
An interesting sidelight on the salon is the announcement of how the various countries fared as to the number of successful exhibitors representing the several countries. In the pictorial section the United States exhibitors led with 240 prints from 150 exhibitors, this being 54 percent of the total exhibited, while Great Britain came second with 126 prints (28 percent of the accepted total) from 84 exhibitors. Japan, Austria, Belgium, Sweden, Poland, and France came next in the number of successful exhibitors, the individual totals of the several countries being in the order named. The balance were scattered over many countries. In the technical section, the United States led with 72 prints, followed by 53 from England.

A special apparatus was constructed to assure proper and expeditious judging of the great number of prints submitted. The entire total was passed quickly before the jury in a sort of "preview" to determine the general quality of the submitted prints, after which the final vote was taken more slowly and with full and critical consideration of the quality of the individual prints as they were placed before the jury.

This device, which is an electrical indicator registering the accepting or rejecting vote of the individual judges at the teller's station, together with a triangular revolving easel for placing the print in position for judging, is being made available by the directorate of the Oval Table Society for the use of other photographic salons desiring to make use of these facilities. Requests for the use of this apparatus should be addressed to the Oval Table Society, 10 West 33rd Street, New York City.

And Now the Miniature Flash Bulb

With the Wabash Photolamp Corporation's announcement of a new midget size flash bulb, of which a half dozen can be carried in an overcoat pocket, bulk is no longer a problem for the wayfaring flash shooter. The new bulb is called Superflash No. 1 and is the latest addition to the now widely used fluffed hydronalium wire-filled Superflash bulbs, Superflash No. 2 (the standard size) and Superflash No. 3, which



Three of the new miniature flash bulbs make a comfortable handful

gives three times the illumination of No. 2 and is intended for large areas.

Tests made with Superflash No. 1 indicate that this bulb affords sufficient lumen output to make possible synchronized exposures on fast panchromatic emulsions at stop F:8, shutter speed 1/200th second, and distances up to 10 feet. Another welcome feature of the new midget bulb is that the glass is thicker than in other flash bulbs, an obviously imperative safeguard against bursting under the intense heat generated in such a small enclosure. Some idea of the size of the bulb may be gained from the fact that three cover the area of an open hand.

Jack Price, writing in *Editor & Publisher*, calls attention to the fact that the short height of the new bulb requires a smaller reflector and voices the opinion that "no doubt the manufacturers of synchronizers will be quick to make reflectors to fit this bulb as the demand will require this additional change." He refers, of course, to the fact that, in order to operate at full efficiency, the wire filled portion of the bulb must be set at the center of the reflector.

While the midget flash bulb was still in production and not yet on the market at the time of this writing, it will be available by the time this announcement appears. Just in time, too, for parties, street shots, all kinds of indoor picture-taking—and a dozen lights for a dozen shots comfortably carried in the two pockets of an overcoat.

Zeiss Ikon Exhibition

If you own a Zeiss Ikon camera, here's your chance to show off what you have done with it during the past year. The Fourth Annual Zeiss Ikon Exhibition will be held the latter part of January in New York City, after which it will make a tour of the United States. The closing date is December 31, so you'll have to step on it if you think you have something that looks good. All entries should be marked: "For Annual Zeiss Ikon Exhibition," and addressed to Zeiss Ikon Company, 485 Fifth Avenue, New York City.

"As before," the announcement says, "there is no restriction as to subject matter, and it is our desire to show the various ways in which photographers are applying Zeiss Ikon cameras in pictorial, commercial, industrial, theatrical, press, color, candid, scientific, and medical photography, as well as the many other uses and applications of photography in American life and industry. Color pictures, whether in the form of prints or transparencies, halftone or photolithographer's proofs, will be exhibited with full credit to all concerned in the making of such pictures. While only a limited number of transparencies can be exhibited, provision will be furnished for showing these to their best advantage.

"Finished prints measuring from 8 by 10 to 11 by 14, or larger (all preferably unmounted), test prints, or negatives may be submitted for consideration; transparencies may be mounted or unmounted; and color prints or proofs should be unmounted so as to facilitate mounting under matte and protective transparent surface."

"Framing" the Distant View

A telephoto lens is not always the best one for recording the distant landscape, for in some instances it is preferable to include part of the foreground—"framing" of the distant scene through the use of trees, a hilltop or a road so arranged in the camera finder or ground glass that this foreground material is made to enclose or "frame" the view in the manner indicated in the accompanying illustrations. This is not only a practical device but, we submit, is interesting pictorially. The pictures shown are not the best examples of the idea we have in mind, but they serve to make the idea clear.

In pictorial arrangements of this kind, the foreground will often be in shadow, and that is really best in order to achieve depth and reality. If the shadows are too deep for straight enlargement of the entire negative, it will be necessary to do some dodging in

Framing the distant view—A

Framing the distant view—B

order to permit a greater exposure time for the distant view than for the foreground. This was the procedure adopted in the case of Distant View—B, in which the horizontal foreground detail as well as the tree at the right were "held back" during part of the total exposure.

A picket fence, a bench on a hill, a human figure, will often be useful in this connection and in many cases much more effective and striking than a tree or hilltop. Whatever you may wish to adopt to bring about the "framing" discussed, we believe this to be a valuable aid to the photographer seeking ways and means of photographing distant views, yet retaining an impression of the viewpoint whence it is seen.

Record Speed Films

THE highest speed yet attained in film emulsions is claimed for three new films by the sponsors, Agfa Ansco Corporation. Two of the films are intended for the use of the gentlemen of the press, though there is nothing to stop the rest of us from trying them out, and the third is furnished in 35-mm, 36-exposure spools for miniature cameras. The press films, Superpan Press and Super Plenachrome, are claimed to have a speed of from three to four times greater than present "super" types of photographic film, while the 35-mm film, called Agfa Ultra-Speed Panchromatic, has about the same speed.

"This amazing gain in film sensitivity," the company points out, "will mean an advantage of 1½ to 2 full lens stops to the photographer, or a permissible shutter speed that is three to four times as fast as that previously necessary. . . . Press photographers will find this extra speed extremely valuable in their work, for in some instances ordinary Mazda light or normal room illumination will be sufficient for pictures."

These new films and particularly the 35-mm film will be useful in stage photography, candid camera work and under other conditions of relatively low illumination or where speed is called for.

The 35-mm film is available in a new type of 36-exposure daylight-loading cartridge for the Leica and similar cameras and in a 36-exposure daylight loading spool for the Contax and similar cameras.

The company claims that the film speed was attained without sacrificing such other desirable characteristics as keeping quality, clarity, proper gradation, and color sensitivity. Superpan Press is slightly faster than Super Plenachrome Press, particularly in artificial light. Both films are available in standard sizes.

In addition to the 36-exposure roll, the Ultra-Speed Panchromatic may also be obtained in 27½-foot and 55-foot containers of film notched and tongued for easy division and darkroom loading in 36-exposure lengths, and in 100-foot lengths of unnotched film.

A new development in connection with the introduction of Ultra-Speed may be the answer to the long-standing criticism of the 35-mm film roll that it takes too long to expose the full roll of 36 pictures and won't somebody please do something about it. Agfa announces that the new film as well as three other Agfa 35-mm films are obtainable in 15-exposure darkroom loading lengths. The films are wrapped in black paper and sealed in aluminum containers and are furnished with tabs which provide easy loading in the darkroom onto the spool of the camera magazine. A 5½-inch tongue on the other end of the film simplifies loading into the camera. Besides Ultra-Speed, the films in which these new darkroom loadings are available include Superpan, a supersensitive panchromatic material; Finopan, a fine grain panchromatic film, and Infra-Red, a film for special effects such as night scenes in sunlight.

Developer for Increased Film Speed

A FINE-GRAIN developer for which contrast, shadow detail, and full gradation are claimed in addition to increased exposure

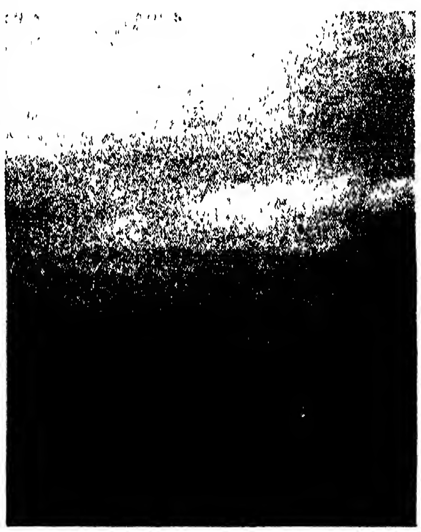
speed for 35-mm film, is announced by the Edwal Laboratories. Edwal-12 is the developer. For pictures made between 9 A.M. and 4 P.M. the manufacturers suggest the use of the following daylight Weston and Photoscop-Scheiner ratings:

	To Daylight		To Mazda	
	Weston	Photoscop Scheiner	Weston	Photoscop Scheiner
Agfa Superpan	64	27	40	25
DuPont Superior	64	27	40	25
Eastman Super X	64	27	40	25
Eastman S.S. Pan.	40	25	24	23
Panatomic	40	25	24	23
Finopan	32	24	20	22
Parpan	32	24	20	22

These ratings refer to bright sunlight. Before 9 A.M. or after 4 P.M. or on cloudy, smoky, hazy days, the Mazda readings are recommended.

SPACE

THE sweeping atmosphere of space is depicted photographically by contrasting a small object with a wide expanse of sea, land, sky, or similar area. The white sailboat in "Alone" stands out prominently despite



"Alone"

its distance and therefore smallness, because it is practically the only point relieving the monotony of sky and clouds and water. Moreover, because it is so small the vastness of sky and water is dramatically portrayed.

THE GEVIRETTE MINIATURE

JUST a handful—measuring 2¾ by 2 by 3¼ inches—is the Gevirette, a new miniature in the popular price field, which has been introduced by Willoughbys. An ever-ready case is available for the Gevirette at a proportionately low price.

Considering the price, the Gevirette has many splendid features to commend it to the amateur who wants a reliable miniature that he can carry with him on all occasions without the inconvenience of weight or bulk. Equipped with the fast Radionar F:2.9 anastigmat lens and a Compur shutter permitting speeds from 1 second up to 1/300th, as well as time and bulb, the Gevirette takes 16 pictures size 1⅝ by 1¼ inches on standard No. 127 roll film. It is finished in chrome and has an all-metal body covered with leather.

18984

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 45*)

"Calicel," is cooled at between 10 and 40 times its original volume.

Calicel, the announcement from the Celotex laboratories indicates, is expected to find wide use in noise correction for the monumental type of structure—railroad terminals, churches, theaters, school auditoriums, and the like—where stone is essential for maintaining the decorative and architectural scheme.

The actual production of Calicel acoustical tile is like that of any standard floor or wainscot tile in that the aggregate is thoroughly mixed with a time-tried mineral bonding agent, then molded with hydraulic presses, after which it is cured or dried in kilns. The aggregate is unaffected by moisture and contains nothing that is food for rodents or vermin; also it contains no combustible material and is therefore fire resistant. A considerable range of color and texture finishes and designs has been developed.

Personal Impressions of the Elmira Meet

SPACE will not permit us to give a full account of the Elmira glider meet which, moreover, was fully reported in the press in the matter of records, mishaps, prizes, and so on. But perhaps from the point of view of those interested in the glider art the personal impressions of Earl R. Southee, one of the best informed men on gliding in the United States, will be of greater interest.

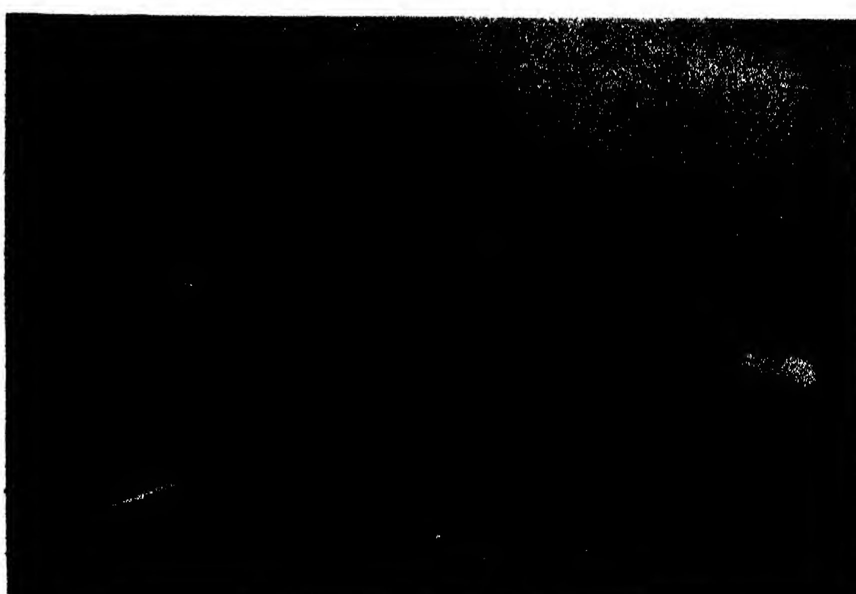
This is what Mr. Southee told us, in brief: In design, performance, construction, and finish American gliders are now ahead of the German gliders. A great many of the American gliders are entirely home-made. Young Americans have not lost Yankee ingenuity and resourcefulness and can achieve much in small shops of the home-equipped variety. Finally, Mr. Southee was greatly impressed by the fact that Messrs. Paul and Ernst Schweitzer, operators of a Peekskill garage, managed to produce an aluminum glider which embodies every refinement of metal construction known to the art, including stressed skin, flush type rivets, and so on. Our heartiest congratulations to these skilled and determined amateur builders. They have done well in particular to disprove the fallacy of the statement that metal construction cannot be applied to gliders.

The Schweitzer model received third place in the Eaton design competition, and was second in the long utility flight. Of the utility type, the Schweitzer glider has a span of 38 feet 4 inches and weighs only 290 pounds empty. The wings are of monospar construction with metal covered torsion leading edge and fabric covered rear section. The wings weigh three-quarters of a pound per square foot. The front of the fuselage is monocoque, and the rear a steel-supported tubular tail boom.

The glider may be entered easily and the pilot enjoys unimpeded vision. There are landing wheels but it will be noticed how little aerodynamic projection they offer. The cabin is entirely enclosed in transparent plastic material, finely worked out in the design. We enjoy seeing originality and departure from German ideas in this art, although we have the utmost respect for what the Germans have done in this field.—*A. K.*

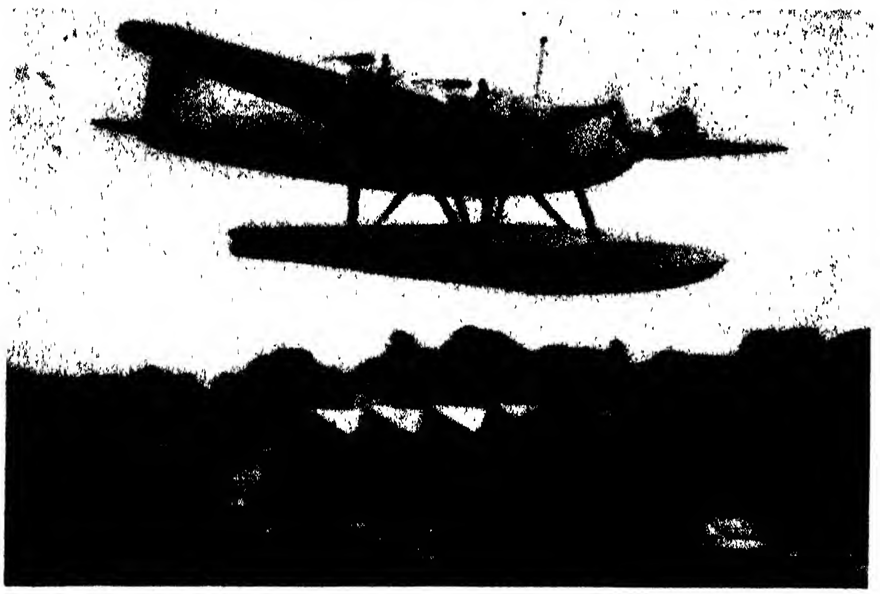
Newspapers to Help Seaplane Landings

LANDING on "glassy" water, so calm as to be without a ripple, is a most difficult feat for a seaplane pilot, because he cannot tell the distance of the water within 10 and sometimes within 50 feet. The difficulty is all the greater when the shore-line or horizon is obscured by fog or haze and there is nothing by which to judge height above the water. One way to meet the situation is to "stall" the machine; that is, to raise the nose to an angle well above the horizon and to let the machine land roughly and more or less at hazard. But this is not a reasonable way to land if long life is expected of the hull bottom, which strikes the water with considerable impact pressure.



The Schweitzer glider described above

Two views of the Mercury, upper component of the Mayo composite seaplane



The *News Letter* of the Aero Insurance Underwriters gives a useful suggestion. The seaplane pilot should come down to a low altitude and throw out a handful of newspapers. The newspapers floating on the water allow him to judge height. Another dodge is to throw stones and land by observing the ripples. Seaplane piloting calls for many such wrinkles in seamanship and airmanship.—*A. K.*

The Mayo Composite Seaplane

For achieving transatlantic flight on a commercial basis, and securing pay load in spite of the huge amount of fuel that has to be carried, there have been proposed or tried the floating islands or aerodromes; flight in the stratosphere; stops at the Bermudas and the Azores; use of the shortest over-sea route between Newfoundland and Foynes Bay in Ireland; catapulting float seaplanes from the deck of a steamship; and the composite seaplane.

The idea of the composite seaplane is due to Major R. H. Mayo of the Imperial Airways, a man of great ability. A very large flying boat is to carry aloft a moderately large seaplane. Since the seaplane is to be launched or released from the flying boat when a considerable altitude has been attained, it should be perfectly safe to overload the seaplane much more than would be the case if it were launched from a catapult since there might be "stalling" after the catapulting. The idea is simple in principle and success of operation is assured, but the construction of the composite aircraft has necessitated the most careful and complex engineering.

The "lower component" of the composite seaplane is a four-engined flying boat similar to the Short Empire boats, with a span of 114 feet and with a total take-off power of nearly 4000 horsepower. It calls for no special comment, except that it is a finely built, modern aircraft thoroughly capable of regular independent operation.

The lower component carries on top of its wing a strongly built tower, on which the "upper component" is firmly mounted. One of the principal problems which had to be overcome in connection with the design of the dual aircraft was the mechanism for interlocking the two planes during the take-off and release. The design evolved has been subjected to exhaustive tests and there is not the slightest doubt that the mechanism will function adequately.

The upper component has been termed the Mercury and is a twin float seaplane, with four engines with a maximum output of 1360 horsepower at 13,000 feet altitude. The engines are of a type not known to

American practice, being 16-cylinder air-cooled engines of H form built by Napier. The span of the Mercury is only 73 feet and it has the moderate gross weight of only 20,000 pounds. What is extraordinary is that, thanks to the extremely heavy loading (made possible by launching at altitude) of 32½ pounds per square foot of wing area, a fuel load of nearly 10,000 pounds will be combined with full passenger comfort, a mail load of 1000 pounds and a range of 3500 miles at a cruising speed of 170 miles per hour. This should be sufficient range to make the north Atlantic crossing even with a continuous head wind averaging as much as 60 miles an hour.

During the climb prior to release, the lower component will be as lightly loaded as possible and both sets of four engines will be co-operating, so that enormous power reserve will give a very rapid climb to the desired altitude.

Some contrary arguments have been made: That it is easier and cheaper to operate a catapult from a surface vessel; that passengers will not like being launched in any fashion; that the next size in flying boats will meet the challenge of non-stop Atlantic operation. Nevertheless, the plan remains very interesting and plausible.—*A. K.*

HAIR WIRE

Copper wire about the size of the human hair and totalling 3,016,000,000 feet was required for constructing the coils of electric clocks in 1937 by the Telechron Company. This footage, if stretched out, would encircle the globe 23.2 times.

New York versus Baltimore

There is constant rivalry between New York City and Baltimore as to which will be the terminal of the transatlantic airways. During the summer and early fall, Pan American Airways has been operating from its temporary base at Port Washington, Long Island, some 25 miles from New York City. For the winter months Pan American is moving to the milder climate of Baltimore. Because the city of Baltimore has been so co-operative and far-sighted there has been a good chance hitherto that the terminal would be permanently located in the more southern city. But New York City is now meeting the challenge by an enormous extension of both the land and water facilities of the North Beach Airport, at a cost of 12,762,000 dollars. The extension will be completed well ahead of the World's Fair, and the Sunrise Highway will connect North Beach with Triborough Bridge, with only a ten-minute drive from bridge to airport.

The plans call for a final area of 429 acres or four times the size of the present airport. There will be two administration buildings, one for land planes and one for seaplanes. The land plane building will be placed at the center of a semi-circular row of two-plane hangars; it will be fireproof, 304 feet long by 77 feet wide, with a semi-circular pavilion 175 feet in diameter on the side facing the field. A covered platform will run around this pavilion and extend out upon the roof of rectangular wings. A semi-circular public concourse, 80 feet in diameter, is to occupy the center of the building, lighted through glass-brick upper walls.

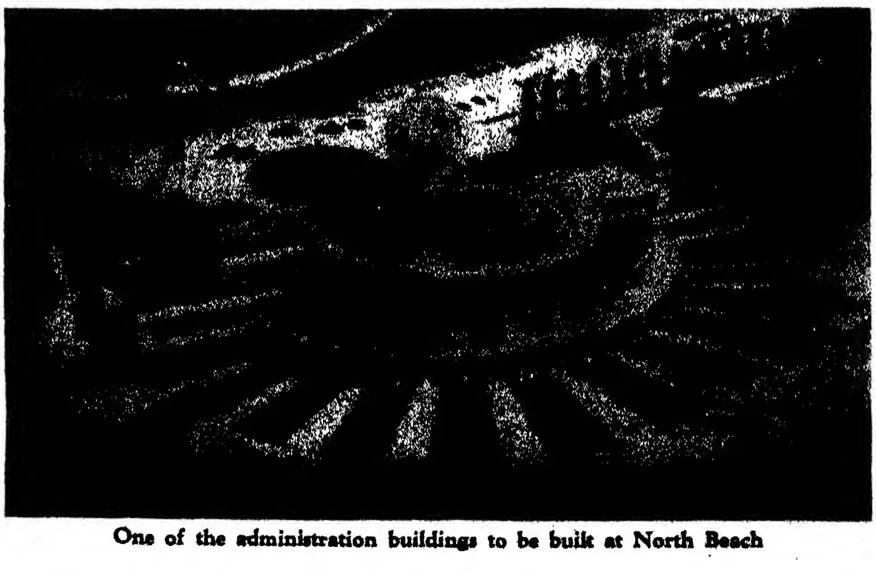
The circular seaplane building adjoins the four-plane seaplane hangars forming four sides of a hexagon. The runways will be built with an asphalt or tar surface until the filled-in ground has settled, when they will be resurfaced with concrete. An airplane taxi runway will make possible quick and easy transfer between transoceanic and transcontinental planes. A covered ramp will connect the landing dock with the central concourse of the seaplane building.

The project is sound in its engineering and aircraft features, and gives promise of being highly satisfying to the eye.—*A. K.*

Is Aviation Paying Its Way?

Aviation has now become a great industry and the above question is of considerable interest, but like many questions in economic science, it cannot be answered definitely. Perhaps our readers would like to know some of the conflicting factors of the situation.

Total airplane sales for 1937 amounted to something like 115,000,000 dollars; the "big eight" manufacturing companies (Douglas, Boeing, Curtiss Wright, Consolidated, Unit-



One of the administration buildings to be built at North Beach

One of the coking drums that was shipped to the middle west on its own "bottom"

ed, Glen Martin, North American Aviation, and Lockheed) did business ranging from half a million to 31 million dollars each, and have developed a highly profitable export trade. But the margin of profit is only 9 percent, leaving little reserve for leaner years and less successful designs. A tremendous handicap for our manufacturers of military and naval aircraft lies in the long elapsed time between the building of a successful experimental model and the final production orders. Naturally, the Army and Navy have to make sure by long service tests that the ships are just right, but in the meantime the expense of a "waiting" and partially idle plant are overwhelming. Low-powered airplanes of the Aeronca and Taylor Cub type, for example, are a bright spot in the industry, and about 2000 of these small machines were delivered in 1937.

On the transport side of the industry there is rapid and steady growth, with several of the major airlines doing an annual business of more than ten million dollars. So great are the expenses, however, over and above the simple elements of fuel, oil, and pilot's pay, depreciation of equipment, communication, aids to navigation, and innumerable other items, that the margin of profit is less than 1 percent, and the border line between profit and loss is woefully thin.

Since 1927 the country has invested in public financing of the aviation industry some 120,000,000 dollars. Total profits for 1937 will be about 10,000,000 dollars. Then there is a large amount of capital which was invested before 1927, and important sums have gone into the industry privately, so that the real return on invested capital is rather slim.

We will leave conclusions to our readers.—*A. K.*

On Its Own "Bottom"

ONE of the strangest freight shipments ever made in the United States recently completed its long journey from The M. W. Kellogg Company's plant in Jersey City, New Jersey, to Whiting, Indiana. It consisted of four coking drums, the dimensions of which prohibited shipment by rail, steamer, or barge. Careful check-up of bridge clearances, channel depths, and so on, proved the feasibility of launching the drums into New York Bay at Jersey City and towing them to Whiting by way of the Hudson River, the New York State Barge Canal, up Lake Erie to Detroit and on through Lake Huron into Lake Michigan to Whiting.

As each drum was 60 feet long and 16 feet in diameter, and weighed 175,000 pounds, it was necessary to load them on special flat cars at the Kellogg Plant for transfer to New York Bay, where they were lowered into the water. The immense diameter of the drums not only necessitated the entire suspension of all other railroad traffic while they were in transit from plant to dock, but it was also necessary to build special tracks within the plant and to cut special doors in the walls to permit their egress.

The dimensions of each of these four drums are: Length 60 feet; weight 175,000 pounds; content 8900 cubic feet; wall thickness $1\frac{3}{16}$ inches.

SIGNS

A NEW night highway sign uses rhodium plating for its letters which shine when automobile headlights strike them. Rhodium is used because of its qualities of high reflectivity and non-corrosion.

Snakes Used in Medicine

SERPENTS twain wreathed the staff of Aesculapius, classic patron of medicine; a brazen serpent upraised in the desert healed the stricken Israelites who only looked on it.

How deeply entwined with medical lore everywhere and in all times is the subtle snake, Clifford H. Pope bears witness in his new book, "Snakes Alive."

We are used to hearing, in a superior sort of way, about the weird ingredients of native Chinese drug-messes, and so are not surprised to learn that the Chinese pharmacopeia includes snake "slough, skin, bile, flesh, fat and oil, head, eyeballs, eggs, and bones." Yet "snake oil" is still a widely sold commodity in these Enlightened States of America—and it is usually faked at that!

Federal seizure and condemnation of "rattlesnake oil liniment" that contained "little, if any, snake oil" is a matter of recent record. And in France a "treacle" of snake-ingredients survived as an official remedy as late as 1884.

Two hundred years ago, a favorite English remedy for scurvy was "viper bread," which contained powdered viper's flesh and sarsaparilla, while for inducing a sweat physicians recommended "compound tincture of vipers" which was declared very successful in the Great Plague of London in 1665.

In 1685 Madame de Sévigné, one of the most cultured of Frenchwomen, recommended vipers in one of her famous letters:

"They temper, purify, and refresh the blood. But real flesh must be used, not the powder. Ask M. de Boissy to send you ten dozen vipers. . . . Take a couple every morning, cut off the heads, have them skinned and chopped up and stuffed in a chicken. Do this for a month, and then blame your brother if M. de Grignan does not become as well as we could wish him to be."

QUARTZ "PIPES"

HOMES of the future may be illuminated by a network of transparent quartz rods which transmit the light from a single bulb, suggests a scientist. The quartz rods would act as pipes, the light "flowing" through them as does water through an iron pipe.

Idle Land May Yield a Profit in Timber

ONE of many examples of idle land which has been made to yield good returns by planting it to trees—and letting the trees grow into money—is in the files of the United States Forest Service.

A New England farmer owned a three-acre sidehill pasture that was practically worthless. He set out 1400 seedling white pines on the hillside. Twenty years later the farmer died, and among his assets was this small tract of young pine. Much to her surprise, his widow was offered 300 dollars for the tract and sold it. About 15 years later a lumber company paid 1000 dollars for it.

Making Water Wet

DESPITE its universal reputation for wetness, water can be improved in this respect by the addition of what are called wetting agents. The applications of these materials which reduce the surface tension of water range all the way from fire extinguishing liquids, soaps, adhesives, insecticides and dust prevention to lead pencils and shampoos.

Many chemical reactions useful in industry are performed more easily, according to P. E. Hattinger in a recent article in *Chemical Industries*, by the addition of wetting agents to improve the contact between a water solution and an oily material. The effectiveness of fire extinguishers depends upon securing intimate contact between water and the combustible material. This is improved by the addition of a wetting agent. Adhesives stick tighter and spread more evenly if a small amount of wetting agent is included in their composition. This may be included in the dry material or added to the solution.

Wetting agents are necessary in practically all agricultural insecticide and fungicide mixtures. By securing a complete wetting of the plant by the poison the effectiveness of the treatment is greatly improved. Indeed, some of the wetting agents used (lauryl rhodanate, for instance) are of themselves poisonous. Similarly, when the problem is to remove the insecticide from the fruit after it has served its purpose, wetting agents again make the task easier.

Dust explosions in mines are minimized by the addition of small amounts of wetting agents to the water used to spray down the dust. Patents have recently been granted to a German lead pencil manufacturer covering the inclusion of a wetting agent in the pencil leads to improve their properties. Numerous shampoos avoid the use of soap by including a wetting agent which leaves no residue on the hair.

Among the most important of the modern synthetic wetting agents are alcohols made from the acids of fats and their sulfuric acid derivatives as well as a number of sulfuric acid derivatives of coal tar and petroleum products.—*D. H. K.*

Tiny Ball Bearings, Size of Pin Head

TINY, precision ball bearings are now being manufactured in Switzerland, reports *Science Service*. In overall size, including the ball race, they are no longer than the head of a pin. They can be substituted for jewel and plain bearings in all forms of clockwork, motors, delicate machines, and sensitive measuring apparatus.

They are particularly useful for aviation instruments because they can withstand shock and vibration better than jewel bearings. Tests on the reduction of friction obtained have been made for comparison with jewel and plain bearings. The ball bearings have an extremely low coefficient of friction so that only approximately the same force is required for starting as for running.

The smallest ball bearings now available (1.5 millimeter diameter) have three balls and the larger ones have eight. It is claimed they operate satisfactorily up to 10,000 revolutions a minute. Only 15 percent as much oil is needed for lubrication as is required for plain bearings, so that they do not need lubrication for years in a small unit. The machined accuracy of the bearing is plus or minus 1/10,000 of an inch.

Unpasteurized Milk Still Consumed by More Than Half of United States

MORE than one half of the 123,000,000 people in the United States are still consuming potentially dangerous raw, or unpasteurized, market milk even though the public health importance of milk pasteurization has long been established, Dr. James A. Tobey, prominent New York health expert, recently told the annual convention of the International Association of Milk Dealers. Only about 47 percent of the fluid

milk produced in this country is pasteurized.

"In 1936 there were 42 epidemics of milk-borne diseases in the United States, involving 1547 cases of preventable diseases, and 28 unnecessary deaths, as reported by the United States Public Health Service," said Dr. Tobey. "In every instance these unfortunate outbreaks of typhoid fever, septic sore throat, scarlet fever, and other communicable diseases were caused by infected raw milk of low grades. The only gratifying feature about these epidemics is the fact that the number is less than the country's average for the past 10 years, indicating a gradual improvement in the small town and rural milk supplies in which most of these outbreaks occur.

"Although the organized medical profession, as represented by the American Medical Association, strongly advocates pasteurization, many individual physicians do not seem to realize the significance of this necessary process. In some parts of the country, education of the professional man in this respect is as much needed as is education of the presumably more ignorant layman.

"The opinion was once prevalent, and is not yet wholly dispelled, that pasteurization is merely a corrective for an impure milk supply. Today that idea is a delusion, for pasteurization is not, and is not intended to be, a substitute for sanitation in milk production. The process renders a clean milk safe and helps to guarantee its purity, but it does not in any way obviate the necessity for an original milk supply of high quality.

"Another common delusion has been the erroneous idea that pasteurization exerts an adverse effect upon the nutritive properties of milk. Actually, however, milk that has been pasteurized by modern methods is virtually equivalent in food value to raw milk."

ELECTRIC EELS

ELECTROPHORUS electricus, the electric eel, can produce up to 500 volts. A baby eel only eight inches long can produce a voltage equal to that used for electric lights in the home, while one a yard long can produce the higher voltage mentioned above.

"In the Full of the Moon"

RURAL folklore the country over declares that moonlight has some sort of effect on crop growth. Whether it is stimulating or depressing depends on the local variation of the superstition. Certainly the actual effect—if there is any—must be small, but plant physiologists have not been absolutely sure that it might not exist. When all the factors that influence plant growth are considered, it becomes very difficult to assign any values to this one factor.

Some elements of the problem have just been attacked in experiments with the effects of polarized light on plants conducted in the Division of Radiation and Organisms of the Smithsonian Institution. The results are reported in a paper prepared by Dr. Earl S. Johnston.

Moonlight is "polarized sunlight" reflected from the surface of the earth's satellite. That is about the only qualitative difference between moonbeams and sunbeams that science can easily put its fingers upon.

Dr. Johnston experimented with oat seedlings, measuring the quantitative effects of the two forms of light on two fundamental phenomena of plant life. One was phototropism, the tendency of a plant to bend toward a source of illumination. Thus, a sunflower "follows the sun."

This behavior is explained by the finding that growth is slightly inhibited on the illuminated side. The tip of the plant bends in the direction of least growth. Thus a measure of the amount of phototropism induced becomes a rather delicate measure of the growth-inhibiting effect of different wave bands and intensities of light.

The other was carbon-dioxide assimilation. The basic phenomenon of plant growth is the capacity for taking carbon dioxide out of the atmosphere and making use of it, through the fundamental process of photosynthesis, in the formation of carbohydrates (sugars and starch), which are the food substance of the plant itself, as well as the basis of all life.

A plant's carbon-dioxide assimilation capacity has been found to vary quite markedly according to intensity, wavelength, and time of illumination.

If a difference could be found in either of these processes dependent on the polarization of light, some basis might be established for the supposed lunar influence found in folklore.

Dr. Johnston used polarized and non-polarized light in carefully balanced amounts from one electric lamp and tried to "balance" their effects. He found no difference whatsoever, he reports, within the limits of experimental error. If there is any difference it must be sought in relation to some other factor in plant growth, or to some quality in moonlight other than polarization.

Alloy Radium Bombs

TO avoid danger from the radiations of radium, it has been customary to keep this element in heavy lead bombs which confine the radiations. Recently a new alloy, half again as heavy as lead, has been formed of tungsten, nickel, and copper, which is more efficient than lead for this purpose and thus permits smaller bombs to be used safely. The new alloy has a tensile strength higher than that of mild steel, resists corrosion, and takes a high polish. Other uses for it are in balancing crank shafts of racing cars, gyroscopes, and other rapidly rotating parts.—*D. H. K.*

Heart Disease Strikes Doctors Twice as Often

HEART disease is much commoner among doctors than bankers or any other occupational group. The reason is to be found in the heavy strain under which the doctor or surgeon constantly labors, explains Dr. Harry L. Smith of the Mayo Clinic.

What is a crisis for the banker or the business man is more or less a routine for the doctor. The physician's and, especially, the surgeon's daily responsibilities are near-

ly as intense as those of the banker when there is a run on his bank. This is Dr. Smith's explanation of the fact that physicians suffer so much more frequently from coronary sclerosis than do persons in other occupations. In fact, this type of heart disorder is sometimes called the "disease of doctors."

Recently Dr. Smith made a comparative study of the incidence of coronary sclerosis among physicians, bankers, lawyers, clergymen, laborers and farmers who came to the Mayo Clinic. About 300 men in each of these occupations were examined; their average age was approximately the same. Coronary sclerosis occurs among doctors twice as frequently as in any other occupation, his study showed. It occurs four times as often as it does among laborers and farmers and about twice as often among bankers, lawyers, and clergymen as among laborers and farmers.

Stress, strain, and worry are called predisposing causes of this disease, which figures hardly at all among the manual laborers and is highest among those who do mental work.

In partial explanation of his findings, which are reported in the *Journal of the American Medical Association*, Dr. Smith declares: "A physician's schooling is long and intensive compared with that of the average banker and business man. A doctor has used up a great deal of nervous energy by the time he has finished school. The nature of his work is much more strenuous, for oftentimes the responsibility of life itself is on his hands. A physician's routine work, which includes ordinary obstetric cases with complications, broken legs, severe cardiac diseases, scarlet fever and diptheria among children, and pneumonia among the aged, and the responsibility of the surgeons, which is probably greatest of all, is actually or nearly as intense as that of the banker when there is a run on his bank."—*Science Service.*

ABRASION-TESTING OF SURFACES

HOW long will the finish on a product withstand wear and abuse? How does a competitive product check with the claims of the salesman and with the material one manufacturer is now using? These and other questions of a similar nature are vital in the determination of what paint, lacquer, or metal plating should be used in finishing a product. They may be answered by abrasion testing the surface with the Taber Abraser which has been developed by the Taber Instrument Company.

As shown in an accompanying illustration, the Taber Abraser is a light, compact instrument. It gives a numerical wear rating to the tested specimen in terms of "wear cycles." The mechanism consists mainly of a power driven specimen holder, a reset counter, two ball-bearing pivoted pendulum arms, on which are mounted wheels made of a special resilient abrasive composition. The wheels are offset relative to the center of the specimen holder, resulting in a unique criss-cross abrading action as one wheel rubs from the inside of the wear pattern outward and the opposite wheel from the outside inward. This rubbing action is comparable to the wear materials receive under actual service conditions. The motor drives

To test abrasive resistance

the specimen through approximately 50 wear cycles per minute and ordinary materials have a range of 100 to 2000 wear cycles (2 to 40 minute test), depending on their durability. The life of the abrasive wheels averages better than 50 tests, depending, of course, on the type and durability of the materials tested.

The toughness and adhesion test assembly with standardized tungsten carbide tipped cutting tool determines the dig resistance, toughness, and adhesion of enamel finishes. The special contour blade removes the enamel coating down to the metal specimen plate under a loading indicated on the scale beam. Toughness or dig resistance is rated by the load required to drive the tool completely through the coating. Poor adhesion is indicated when the enamel chips away from the specimen plate as the sharp edge of the tool shaves through the coating. The continuity of the shaving peeled off is also an indication of the elasticity of the enamel finish.

HEAT TREATED PHOSPHATE FERTILIZER

THE rate of cooling of heat-treated phosphate rock after its fluorine content has been removed by calcining with steam affects the availability of its plant food content. If treated phospate rock is cooled quickly the proportion of its phosphoric acid content available to plants may be above 90 percent, whereas if it is cooled slowly its phosphate content may largely return to an insoluble form which plants cannot use.—*D. H. K.*

HIGH TEMPERATURE ELECTRIC FURNACE ELEMENT

AN electric furnace element capable of operating at 3000 degrees, Fahrenheit, was recently exhibited under operating conditions in Pittsburgh. The element has been developed by Dr. Paul Schwarzkopf, a famous pioneer in powder metallurgy, in his laboratories at Reutte, Austria. The makers claim that such elements, after operating 4400 hours at a temperature of 3000 degrees, Fahrenheit, have shown no evidence of deterioration. As a result of tests made in Europe, the element appears to be resistant to hydrogen, oxygen, hydrocarbon, and sulfur and its combinations. The element holds

out much promise of being used in air, neutral, reducing and oxidizing atmospheres, in vacuum, or even in sulfurous atmospheres. It should, therefore, be suitable for use in glass and ceramic furnaces, as well as in the metal industry.

If the element has all the characteristics claimed for it, it will open a much larger field for the use of industrial furnaces and might in time even be used in the electric kitchen stove, where it would give the electric stove the quick cooking characteristics of the gas stove. The present tests, however, will be confined entirely to the use of the new element in industrial furnaces. The elements now in use in electric furnaces can not reach higher temperatures than about 2400 degrees, Fahrenheit, and have certain disadvantages which the new element does not seem to have.

Deep Wells Replace Rain Dance

THE rhythmic clank of the drilling rig is successfully displacing the tomtom of the rain dance as a means of getting irrigation water for the sun-cursed desert lands at Acoma Pueblo, New Mexico, reports the Department of Interior.

Ancient legends, telling of a fertile land watered by springs, in the present site of the desert farms of the Pueblos, gave the engineers a hint of possible underground water. Early failure by the drillers seemed to disprove the ideas, but on the advice of the older Indians, engineers drilled a well 1500 feet deep, in a site chosen by the tribesmen.

Seven hundred gallons a minute of pure, soft water gushed forth to prove that the Indians were right in their advice. After this preliminary success, more than 180 wells were drilled to a depth averaging 500 feet.

With a co-operation strangely in contrast to the wars of only a few generations ago, Indians are doing much of the work on drilling these wells, and by agreement with the Indian Service, they will bear the cost of maintaining the wells and ditches and operating the pumps.

These wells may soon usher in a new era in Indian agriculture, lifting it from submarginal in character to profitable, and making Acoma Village self-supporting again, as it was in the distant past before the coming of the white man. Water, to the Indians of the arid southwest, is as important as the "black gold" petroleum of the oil fields; it spells, in fact, life itself.—*Science Service.*

Steel Production

THE United States continues to lead the world in steel production. Figures published in *Steel Facts* show that our production more than triples the second country on the list, and for the first six months of 1937 was 41.9 percent of world production. The tabulation follows:

Country	*Year 1936*	*% of 1st 6 Mos. 1937 Total*
United States	47,768	41.9
Germany	18,856	13.5
Russia	16,083	12.3
Great Britain	11,785	9.1
France	6,595	5.5
Japan	4,945	4.1
Belgium	3,125	2.6
Italy	2,291	1.5
Luxembourg	1,950	1.9
Czechoslovakia	1,535	1.6
Poland	1,123	0.9
Canada	1,078	1.0
Sweden	964	0.8
Estimated Other	3,902	3.3
Estimated Total	122,000	100.0

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

MICROSCOPE EQUIPMENT FOR THE AMATEUR is a 20-page pocket size booklet which describes and illustrates not only microscopes and such equipment as lamps and micro projectors, but also gives some details regarding microscopy as a personal hobby. Prices are quoted on the microscopes and equipment. *Write for Bulletin 138A, Scientific American, 24 West 40th Street, New York City.—3 cents.*

DIRECTORY OF MATERIALS tells where to buy iron, steel, and non-ferrous alloys, plastics, and other nonmetallic materials as utilized in the design of machinery of all types and sizes. It lists 336 trade-named materials embodying 654 different alloys. Nonmetallic materials show 113 trade-named types with 18 individual grades. *Machine Design, Penton Building, Cleveland, Ohio.—25 cents.*

MODERN PLASTICS, Handbook and Catalog Number, Volume 15, Number 2, contains a comprehensive series of articles on various types of plastics, together with advertising that is equally as interesting as the text. The section on product development covers the automotive, aviation, and electrical fields. 342 pages, profusely illustrated. *Breskin & Charlton Publishing Corporation, 425 Fourth Avenue, New York City.—$2.00.*

REFRIGERATION, a textbook for home study, is a multigraphed booklet that illustrates and describes the operation of the various types of modern refrigerators and gives hints regarding the correction of troubles that may be encountered. This is an ideal booklet for those who are sufficiently mechanically-minded to want to know something about the operation and repair of household refrigeration equipment. *Write for Bulletin 138B, Scientific American, 24 West 40th Street, New York City.—50 cents.*

PERTINENT QUESTIONS AND ANSWERS CONCERNING DUSTS is especially concerned with those dusts that contain free silica and cause the disease of the lungs known as "silicosis." The text is in question-and-an-

swer form and tells something about the various types of dust and how they may be filtered to eliminate dangers. *Mine Safety Appliances Co., Braddock, Thomas and Meade Streets, Pittsburgh, Pennsylvania.—Gratis.*

Railway Literature For Young People lists books, booklets, and periodicals on railroad transportation subjects suitable for boys and girls ranging up to advanced high school age. *Association of American Railroads, Transportation Building, Washington, D. C.—Gratis to school superintendents, teachers, and librarians.*

Cameras and Film for Amateur Use describes and illustrates a line of reasonably priced cameras, shows some of the work that can be accomplished with them, and gives hints that will be of interest to photographers in general. *Write for Bulletin 138C, Scientific American, 24 West 40th Street, New York City.—3 cents.*

Smithsonian Institution Annual Report for 1936 is a book containing 23 outstanding scientific articles reprinted from different sources and bearing on astronomy, northern lights, radioactivity, low temperatures, evolution, gorillas, bats, birds, aerial photography, petroglyphs, and other general scientific subjects. *Superintendent of Documents, Washington, D. C.—$1.50*

American Beer and Ale, A Handbook of Facts and Figures, gives the answers to many questions about beer and ale which could not otherwise be found without considerable research. The chapter headings give the scope of the book; Definitions, History and Development, Raw Materials, Processes of Production, Health and Moderation, Production and Consumption, Taxes and Allocation, and Brewery Employment. *United Brewers Industrial Foundation, 21 East 40th Street, New York City.—Gratis.*

The Microscope is an attractive new journal of microscopy and photomicrography, published monthly and suitable for the serious amateur. *Arthur Barron, Ltd., 20 Took's Court, Cursitor Street, London, E. C. 4, England.—12 shillings yearly.*

Clear Reception is a folder which deals specifically with the suppression of background noise in radio receivers. It tells how such noises reach the receiver and how they may be stopped either at the set itself or at the noise source. *Write for Bulletin 138D, Scientific American, 24 West 40th Street, New York City.—3 cents.*

Oil Burners for Home Heating discusses the various types of burners now on the market and particularly the question of obsolescence. Almost any questions that oil burner buyers may ask regarding burners and their efficiency are discussed. Circular 406 of the Bureau of Agriculture, *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Gardex "Soil-Flow" Tools is a new catalog that will turn your thoughts toward next spring's gardening operations. It describes and illustrates a line of gardening tools that are new in conception. The use of these tools is claimed not only to be easier on the gardener, but to produce better results with less work. *Gardex, Inc., Michigan City, Indiana.—Gratis.*

Agfa Formulas for Photographic Use is a helpful booklet for the serious-minded amateur photographer who does his own finishing. It includes various types of film and paper developers, short-stop baths, hardening baths, and fixing baths. It also covers reducers, intensifiers, and toning solutions, as well as two types of desensitizers. This is obtainable at photographic dealers or from *Agfa Ansco Corporation, Binghamton, New York.—Gratis.*

Industrial Tire Handbook has been designed to point out ways to save money on intra-plant and industrial hauling, and to tell how to lower costs and speed up plant operations by using the proper rubber-tired wheels on material handling equipment. A simple test described in this booklet can be made by any user or prospective user to show how rubber-tired equipment can reduce abrasive wear on floors, as compared with steel wheels. Another section is devoted to a description of wheelbarrow tires. *Write for Bulletin 138E, Scientific American, 24 West 40th Street, New York City.- 3 cents.*

The Railway Handbook, 1937-1938, compiled under the direction of the Editor of *The Railway Gazette*, is a collection of data regarding the railroads throughout the world. It gives the history of many of the more prominent lines and shows tables of figures on railway mileage, electrification, longest railway tunnels, speed records, Diesel equipment, and so on. *The Railway Publishing Company, Ltd., 33 Tothill Street, Westminster, London, S. W. 1, England.—Two shillings and sixpence.*

Condor Compensated Belts is a new illustrated four-page bulletin describing the reasons for compensating rubber belts and giving the principle on which they are designed. Engineering data essential to the proper selection, application, and supervision of belts is also included. *The Manhattan Rubber Mfg. Division, Passaic, New Jersey.—Gratis.*

Aluminum Paint, its Uses and Application, is of particular interest to the managements of various types of plants and factories, inasmuch as it deals largely with the use of aluminum paints not only to protect plant walls, water tanks, structural steel and so on, but also to increase the light-reflecting ability of walls and hence the general lighting of an interior. Home owners will also find much of value, as a portion of the booklet is devoted to uses of aluminum paint as a priming coat on wooden surfaces such as the exterior of buildings. *Write for Bulletin 138F, Scientific American, 24 West 40th Street, New York City.—3 cents.*

RCA Research and Development is a running story of the work that is being done by the Radio Corporation of America in the development of the art of communication. *Radio Corporation of America, 30 Rockefeller Plaza, New York City.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Strict Construction

NORMALLY the monopoly granted by a patent is not restricted by the exact language of the claims, and the claims are construed so as to cover equivalent structures. Thus where a claim of a patent specifies that certain elements are fastened together by means of a screw, under normal conditions a pin or a rivet is considered to be the equivalent of the screw. A different situation arises, however, where, during the prosecution of a patent application, a patentee avoids a rejection of the claim by inserting an express limitation in the claim. The limitation which is thus inserted in order to obtain the allowance of the claim is considered to be essential and cannot be disregarded after the patent has been issued. To disregard the limitation would be to confer upon the patentee a monopoly which the Patent Office had expressly rejected.

In a recent case before the Circuit Court of Appeals for the Tenth Circuit, involving infringement of a patent on apparatus used in the pumping of deep wells, the Court found that the claims of the patent were not infringed because the alleged infringing device omitted an element which had been inserted in the claims in order to secure their allowance. In this connection the Court stated:

"Where an applicant is compelled by rejection of his application to narrow his claims by the introduction of a new element in order to secure the patent, he is bound by the narrowed claims and cannot subsequent to the issuance of the patent broaden them by dropping the element which he is thus required to include."

Interchangeable

IN the absence of limitations of the type referred to under "Strict Construction," a liberal interpretation is given to a patent and a patentee is not restricted to the apparatus disclosed in the patent. This is exemplified by a recent suit for patent infringement involving electric clocks operated on public lighting circuits. In a clock of this character any failure in the electric current causes the clock to stop, and when the current is resumed the clock again begins to operate, with the result that the time indicated is often inaccurate. The patent in suit relates to an indicator which operates upon the failure of the electric current. The indicator shown in the patent in suit consists of a pendulum normally held out of sight by means of a solenoid. The pendulum and solenoid are so arranged that when the current fails the pendulum swings into view due to the attraction of gravity, thereby giving visible notice that the time displayed by the clock is not accurate.

In the suit under consideration the defendant also employed an indicator operating upon the failure of the electric current. Instead of depending upon the attraction of gravity to cause the indicator to shift into view, however, the defendant employed a spring. It was contended by the defendant that since he employed a spring instead of depending upon the attraction of gravity his clock did not infringe the patent. The Court rejected this contention, however, and held the defendant's clock to be an infringement of the patent, and in this connection stated:

"The force of gravity and a spring, when they accomplish the same result in substantially the same way, have long been regarded as typical equivalents. Indeed, the interchangeable use of weights and springs is the stock illustration for equivalents."

Without Precision

PATENT law is not an exact science and it is often difficult to answer questions relating to this subject with mathematical precision.

The rules of law relating to patents appear on the surface to be relatively simple and understandable. The principal difficulty arises in determining which rule to apply to a given state of facts. This difficulty frequently arises in connection with the question of whether a new combination of old elements is a patentable invention.

In a recent *Federal Reporter* appear two decisions of different United States Circuit Courts of Appeals which contain statements that appear to be in conflict. One decision states:

"Combining old devices into a new design does not amount to a new invention. Putting the lint flue under the ginhouse floor involves only mechanical judgment. The conclusion we reach is that the patent is void for want of invention."

In this case the Court appears to say that a combination of old elements does not amount to invention.

In the second case the Court had the following to say:

"It is true that Tily selected the essential elements of his combination, such as the dies for cupping or corrugating the material, and tags to be pinned, the guide slots through the dies as a pathway for the pin, and a rudimentary pin driver from the prior art, but if the result was novel and useful it was not unpatentable."

In the second case the Court held that a combination of old elements was a patentable invention.

Actually there is no conflict between the two cases. The general rule is that a combination of old elements does not amount to invention where the elements operate in their usual and expected way to produce the expected results. A patentable invention does arise, however, from a new combination of old elements where the elements acting in co-operation with each other produce an unexpected, new, or improved result. In the first of the two cases referred to above the Court was of the opinion that the elements did not produce, in combination, an unexpected, new, or improved result, and accordingly the patent was held to be invalid.

In the latter case the Court was of the opinion that an unexpected, new, or improved result did flow from the new combination of old elements and the patent was held valid.

Private Code

A CABLE or telegraphic code may be protected by copyright according to a recent decision of a United States Circuit Court of Appeals.

The plaintiff in the suit had prepared a cable and telegraphic code which he had published in book form and copyrighted in 1912. The plaintiff had originated some of the phrases in his code and others he had selected from previous codes and then compiled them in alphabetical arrangement. The Court held that the copyright was valid both as to the portions compiled from previous codes and as to the portions originated by the plaintiff. In this connection the Court stated:

"Both the phrases, so far as they were his, and the arrangement were proper subjects of copyright."

The defendant published a similar code and the Court found that portions of the defendant's code had been copied from the plaintiff's copyrighted code. The defendant was adjudged to have infringed plaintiff's copyright and plaintiff was awarded statutory damages of 5000 dollars and also counsel fees of 2750 dollars.

This case illustrates an interesting aspect of our copyright law; namely, that a court has the power to award counsel fees to the prevailing party.

Octane Rating

THE term "Hi-Octane" has been refused registration as a trademark for gasoline on the grounds that it is descriptive of a type of gasoline.

A prominent distributor of gasoline applied for trade-mark registration on the term "Hi-Octane" and after it was refused by the Patent Office an appeal was taken to the Court of Customs and Patent Appeals. This Court sustained the Patent Office, pointing out that the prefix "hi" means *high* and that, accordingly, the term was equivalent to *high octane*. By reference to a number of technical and trade journals the Court showed that high octane was used in designating a type of gasoline, and that accordingly it was purely descriptive. For this reason the Court held the mark was not registrable.

It is interesting to note that in the course of its decision the Court referred to the Scientific American for August, 1932, which contained an article on octane rating of gasoline. It was partially on the basis of this article that the registration was refused.

Books SELECTED BY THE EDITORS

THE ADVANCING FRONT OF SCIENCE

By George W. Gray

A LITTLE army of only 100,000 men, in a world of 2,000,000,000, or one human being in 20,000, is the army of scientists who are advancing like a forest fire across the No-man's-land of ignorance and darkness and rapidly changing the face of the world we live in. So rapid is the advance and so varied the terrain that but few, even among the army of scientists themselves, can survey or even comprehend the whole scene. Mr. Gray, the author, is one of a mere handful of writers who are not professional scientists but who have the breadth and depth of insight into all the fields of science to report intelligently the great panoramic advance. Because of past performances in which all sensationalism and overstatement have been avoided, he has the entrée to all the laboratories and scientific institutions, also the full confidence of the scientists to the extent that they personally co-operate with him in seeing that his interpretations are not mere passable approximations of truth.

George W. Gray

This latest book of his is strictly a reporter's job; he sweeps the whole horizon of science from astronomy and physics and chemistry to biology and its branches. He avoids mere retelling of encyclopedic facts and concentrates on what is news, and it is truly remarkable how much news he has embodied in this book. In any field it answers with a wealth of description the question, "What are the scientists doing now?" No wonder it is a Scientific Book Club selection; it deserves to be; and, in fact, if it does not turn out to be the whole year's best scientific book this reviewer will invite its author to luncheon and eat a copy of it without salt or sauce.—$3.20 postpaid.—*A. G. I.*

THE MODEL RAILROADER CYCLOPEDIA (1937)

Edited by A. C. Kalmbach

A FIRST quick glance through this volume is enough to make one realize what it is about the hobby of model railroad building that fascinates so many thousands of people. Here we have many pictures of the puffing giants of the rails and a great many simplified drawings for the use of those who wish to make miniature models of some of the latest designs. Steam engines, freight and passenger cars, electric locomotives, and electric trolley cars are shown in these drawings. In addition, there are construction diagrams for gate towers, tool supply houses and all the appurtenant equipment to make a complete model railroad. Cloth cover $2.15 postpaid; paper cover $1.65 postpaid.—*F. D. M.*

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA, 18th Edition

By A. L. Dyke

THIS old reliable standby of the mechanically-minded automobile owner, as well as of the repair and service man, appears this year with several new sections. Among these is a discussion of automotive Diesel engines, including 44 illustrations. There have also been added 24 pages of revised 1937 specifications for passenger cars, trucks, tractors, buses, two-cycle outboard engines, and motorcycles. There are 1242 pages in the main section of the book and 70 pages of addenda. It is safe to say that this is the one book that gives a thorough background of knowledge in all automotive subjects.—*Cloth, $6.50 postpaid.—A. P. P.*

PORTRAITS OF THE IRON HORSE

By Otto Kuhler & Robert S. Henry

A BRIEF, compact, popular account of the evolution of the steam locomotive, from 1831 to date. It contains numerous pen drawings of the evolving types.—$2.15 postpaid.—*A. G. I.*

CHINA AT WORK

By Rudolf P. Hommel

AN author who obviously knows his mechanics describes in detail and at considerable length (366 large pages, 535 photographs taken on the spot by himself) all the tools and implements such as have been used by the Chinese people for thousands of years—their shop tools, tools for procuring food, making clothing, building, and for enabling transport, all in vast detail and variety. The effect of reading this splendid book is as though a man thoroughly familiar with China took the reader on a shop tour of the interior and showed him the plain people at work at all their trades. Some of the tools are decidedly surprising and, from some of them, Occidentals might obtain valuable pointers. The Chinese do not like to be photographed, an objection they extend even to their tools, and thus the feat of getting these intimate photographs was remarkable; they even object to the measurement of their tools, and so the author had secret marks on a cane used slyly for that purpose. This reviewer spent many fascinated hours over this book.—$5.25 postpaid.—*A. G. I.*

PHOTOGRAPHY AND THE ART OF SEEING

By Marcel Natkin

WHEN you reach the point where you can "see" a photograph before you actually release the shutter, you have gone a long way toward being a successful amateur photographer. "Seeing" a photograph is an art that can be acquired; the author has here attempted to teach the reader how. Photographs of examples are reproduced and the accompanying short but explanatory text will aid any photographer who has ever sensed the fact, in the darkroom, that he has completely missed a scene that should have been a masterpiece of photography.—$3.70 postpaid.—*A. P. P.*

GIANT LINERS OF THE WORLD

By Alan L. Cary

MARINE hobbyists will love this book. It begins with an introductory statement of some length and then shows pictures, silhouettes, and simplified deck plans of 60 of the largest of the world's mercantile ships. With each photograph and silhouette are given complete data as to the dimensions, the power, the service, passenger capacity, and a brief discussion of some of the structure details. As a reference book of fact concerning these 60 vessels, it is quite complete.—$2.65 postpaid. —*F. D. M.*

ENGINEERING GEOLOGY

By H. Ries, Prof. Geology, Cornell University and Thomas L. Watson, late State Geologist of Virginia

AMONG books published in this country this one is unique: it is the only text on engineering geology. It is a splendid one. This is the newly revised and fifth edition of a solid work that has be-

come a standard. It is a large book—750 pages, 271 illustrations. It covers rocks and rock minerals, rock structural features; rock-weathering and soils; surface and sub-surface waters; landslides and land subsidence; wave action and shore currents in relation to coasts and harbors; lakes and engineering; economic bearing of glacial deposits; geology of reservoirs and dam sites; building stone; limes, cement, and plaster; clay and clay products; coal; petroleum and gas; road foundations and materials; ore deposits; historical geology. This is seen to be a complete sweep of all aspects of the science of geology but with a very preponderant emphasis on the practical and engineering aspects. It might therefore be termed "the practical man's geology," since any practical reader would find its contents as useful as the engineer. Either as a book to read or study, or as a reference book of lasting value, it contains a vast amount of information otherwise obtainable only from a whole collection of books.—$5.25 postpaid.—*A. G. I.*

FAMILIAR FLOWERS OF FIELD AND GARDEN

By F. Schuyler Mathews

YOU no doubt have often puzzled about the identification of some informal flowers which you have seen in a small garden or during a ramble through the woods. The probabilities are that you will be able to find those flowers in the pages of this book, drawn in life-like manner and described in easily readable text. The arrangement is by months so that a running story is presented of flowers in the sequence in which they meet the attention. The text is supplemented by a systematic index of the names, colors, and localities of familiar flowers of the United States. In this, a revised edition of an older work, the author has included much material that brings the text thoroughly up to date.—$2.65 postpaid—*A. P. P.*

WEATHER ELEMENTS

By Thomas A. Blair, Senior Meteorologist, U. S. Weather Bureau; Associate Prof. Meteorology, University of Nebraska

A TEXTBOOK of elementary meteorology presenting, concisely and systematically, an introduction to the science of meteorology in its present stage of development. The atmosphere; methods of observing temperature, pressure and the wind; also moisture, sunshine, visibility, and upper air conditions; solar radiation and its effects; condensation of water in the atmosphere; interrelations of temperature, pressure, and wind; the general and secondary circulations and lesser disturbances; weather forecasting; world weather; climate; electrical and optical phenomena; the work of the United States Weather Bureau—these are the chapter heads, and the whole science is thus seen to be swept over. The treatment is such that any person of average intelligence should have no trouble with it. It is an odd fact that this is the first textbook of general meteorology written and published in the United States in just 25 years. It should similarly occupy the foremost position for a long time to come.—$5.20 postpaid.—*A. G. I.*

THE BIRDS OF AMERICA

By John James Audubon

FOR the first time, about one hundred years after their first publication, Audubon's extraordinarily beautiful paintings of the birds of America are collected in one volume. Five hundred plates in the original colors of the paintings include 435 illustrations from the original "Elephant Folio" and 64 additional ones from the 1840 edition. With each plate is given a brief discussion of the range, habitat and identification characteristics written by William Vogt, editor of *Bird Lore*, who also wrote the introduction. This is one of the most beautiful books that has come to our attention for many a day. Plates reproduce the original colors faithfully by deep-etch offset lithography, each on a separate page 9 by 12½ inches. The volume, bound in attractive, strong buckram, is slightly over two inches thick and weighs, packed in its wooden shipping box, 7½ pounds.—$13.00 postpaid. —*F. D. M.*

THE PROFESSIONAL ENGINEER

By Esther Lucile Brown

AGAIN we can announce a book of value to those contemplating engineering as a profession. This small monograph is general in scope, giving a picture of engineering as a whole rather than the technical details and requirements of any particular branch. The engineer's place in our economy, what is required of him, and what the future holds for him are broadly covered here.—$0.85 postpaid.—*F. D. M.*

PHOTOGRAPHIC AMUSEMENTS

By Frank R. Fraprie and Florence C. O'Connor

IN this, the eleventh edition revised and enlarged, of a popular book on photography that has had a wide sale through many years, the authors have included a large measure of new material. The subject matter covers so many kinds of trick works with the camera that it is impossible to list them all. However, when we say that it treats composite photography, invisible portraits, photomontage, bas-reliefs, and freaks, we have given a general idea of the coverage. Leafing through the volume we find double portraits, two-headed dogs, a surrealist nude, portrait playing cards, and so on. To the photographer who is looking for the unusual to attempt with his camera, this book will open up whole new worlds to conquer and will give him a new concept of photographic possibilities.—$3.70 postpaid.—*A. P. P.*

MAN, BREAD AND DESTINY

By C. C. Furnas, Associate Professor of Chemical Engineering, Yale University, and S. M. Furnas, Formerly Instructor in Nutrition, University of Minnesota

THE story of man's food—what it does to you and why. Energy, quantity, body fuels, vitamins, health, stamina, diet and mentality, dining well, digestibility, germs, cook books, economic aspects of eating, the future of food—these sample items give an idea of the content. This book is all dessert—such fascinating reading, when the usual run of cut-and-dried fare found in food and diet books was expected, that this reviewer, who is ordinarily cynical about the science of diet, and eats whatever he finds on his plate, missed a meal to read it. There is "come hither" in the literary style of this book. —$3.15 postpaid.—*A. G. I.*

AMERICAN STANDARDS OF WRITING

By Robert C. Whitford and James R. Foster

THAT writing is definitely related to talking, reading, observing, and thinking is a fact that cannot be refuted. Thus, in order to achieve a style of writing that will be acceptable to the general reader, it is necessary for the would-be author to study not only what he may consider to be the art of writing, but also the art of these four other methods of obtaining or exchanging information. In an endeavor to instil the fundamentals of writing—structure, style, diction, exposition, and so on—the present book has been prepared. It will be invaluable to anyone who ever has occasion to write anything, whether it be conventional business letters, short articles for the local newspaper, or comprehensive and well-knit articles for magazines. The first part of this book consists essentially of a series of instructions. The second part is a handbook of current usage of words and phrases that often are misused.—$2.15 postpaid.—*A. P. P.*

For sale by
SCIENTIFIC AMERICAN
24 West 40th Street
New York City

SCIENTIFIC AMERICAN

ADVERTISERS

January · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City

Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 158, No. 1, 35 cents a copy, $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • FEBRUARY • 1938

COILED copper water tubing from the Bridgeport Brass Company's automatic machinery, illustrated on our cover, has advantages over rigid copper pipe. There is a saving of space in both shipping and storage; the pieces may be handled with ease on the job. Standard lengths of tube, from 20 to 60 feet, are coiled in a flat "pancake." These flat coils are then annealed so that, slightly softened and ductile, they may be readily uncoiled and fitted to the shape or contours of individual installation requirements.

SCIENTIFIC AMERICAN, February, 1938. Vol. No. 158, No. 2, entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of February, 1888)

CANAL—"The indefatigable de Lesseps has been forced to take a backward step in the construction of the trans-isthmian canal. Finding the work far from complete and his capital approaching exhaustion, he has determined to construct the canal for the present with locks. . . . This is by no means to be interpreted as an abandonment of his original project of a canal without locks. But as a source of revenue, it is absolutely essential that the canal should be in receipt of tolls. Without receiving an income at an early date, the work may have to be abandoned."

VOLAPUK—"For some years past, and much more frequently of late, there have been references in English and Continental journals to the Volapuk, world's speech, or universal language, and it would seem as if in some quarters there is a growing inclination to take its pretensions seriously."

LOST SPECIES—"Those species of North American birds termed 'lost' and excluded from many of the lists in consequence, are at present of considerable interest to many ornithologists, both from the fact that a thorough search may, at any time, reveal the existence of some one, and that within the last few years two at least, the great auk (*Plautis impennis*) and the Labrador duck (*Camptolaimus labradorius*), are believed to have become absolutely extinct."

POUGHKEEPSIE BRIDGE—"This structure, now under process of erection by the Union Bridge Co., of importance both as a monument of engineering and as a link in the railroad system of the Eastern States, is rapidly approaching completion. . . . The cantilever has been utilized as far as possible. Pin fastenings have been used in the more important truss work, and small members have been employed. Almost all the riveting was done in the shops, and the eye bolts, struts, and chords were delivered on the ground ready to be put at once in place without delay. . . . The river is crossed in five spans, involving the placing of four piers in the channel. The clear opening of the spans varies from 500 ft. to 521 ft. 6 in., with 130 and 160 ft. head room. . . . On each of the two piers nearest the shore, four sets of steel rollers, 3 inches by 3 feet 6 inches, and twenty four in a set, carry the ends of the anchorage trusses and of the cantilevers of the east and west spans. These allow for expansion and contraction under changes of temperature."

ELECTRICAL TYPEWRITER "This apparatus, which fulfills the functions of a typewriter at any distance from the keyboard, consists of a type wheel, which contains the letters of the alphabet, numerals, and stops. The rotation of the type wheel is effected by means of intermittent currents transmitted from a commutator under the control of a pianoforte keyboard acting on propelment pallets carried by the lever suspended over an electro-magnet . . . Ink is supplied from an inking wheel."

GAS FUEL—"The American Manufacturer says that Mr. Jacob T. Wainright, a well-known metallurgical engineer of Pittsburgh, Pa., has succeeded in making pig iron with natural gas as fuel."

NO SOCKS—"The experiment, begun some time ago in the German infantry, of doing away with socks and keeping the foot soldiers' feet well greased, has proved thoroughly successful. To say nothing of the economy of the plan, the men march easier, and, generally speaking, show few blisters."

GAS LOCOMOTIVES—"For some time . . . experiments have been quietly conducted by Gen. Supt. W. W. Worthington and the General Master Mechanic of the Fort Wayne, Cincinnati & Louisville road, with a view to the transportation of natural gas in tanks, for use in heating and lighting cars and for fuel in the fire box of the locomotive. The experiments have been successful enough to warrant the hope that the time is soon to come when the public will be able to ride on smokeless and cinderless cars."

ELECTRIC CARRIAGE—"The dog cart represented in the adjoining engraving was built by Messrs. Peck, coach builders of Brighton, and is driven by an Immisch motor of ½ horse power type. The current is supplied by 16 E. P. S. accumulators, which at the normal rate of discharge are good for a six hours' run. . . . The motor at present employed weighs 40 pounds, though it is scarcely large enough for the work it has to do. The experiments so far made have resulted in obtaining valuable data as to the tractive force required for vehicles on roads of various kinds. . . . With a load of two persons a grade of 1 in 30 can be surmounted."

ALUMINUM—"Works for the manufacture of sodium by the Castner process and its conversion into aluminum under the process of Mr. James Webster are now being erected by the Aluminum Company, of St. Mary Axe, London, at Oldbury, near Birmingham. . . . By this process the cost of sodium is reduced from 4s. to 1s. per lb., and of aluminum from 60s. to less than 20s. per lb."

SOCIAL LIGHTS—"The ballroom of Mr. Ogden Mills' residence, 69th Street and 5 Avenue, was lighted by means of the New York Isolated Accumulator Company's storage batteries on Monday night, 16th ult. The occasion was a ball and house warming, and a large assemblage of the leading members of New York society were present. The ballroom was brilliantly illuminated by sixty 16 candle power lamps."

CAST GUNS—"In Europe all the very large cannon are wrought or built up, but we are trying the experiment of casting the steel gun whole, a very much cheaper and more expeditious process. One such gun has been cast in Pittsburgh, and to all appearances it is a success but it has not yet been tested. Should it stand the test of trials, it will mark a great advantage in the making of great guns."

AND NOW FOR THE FUTURE

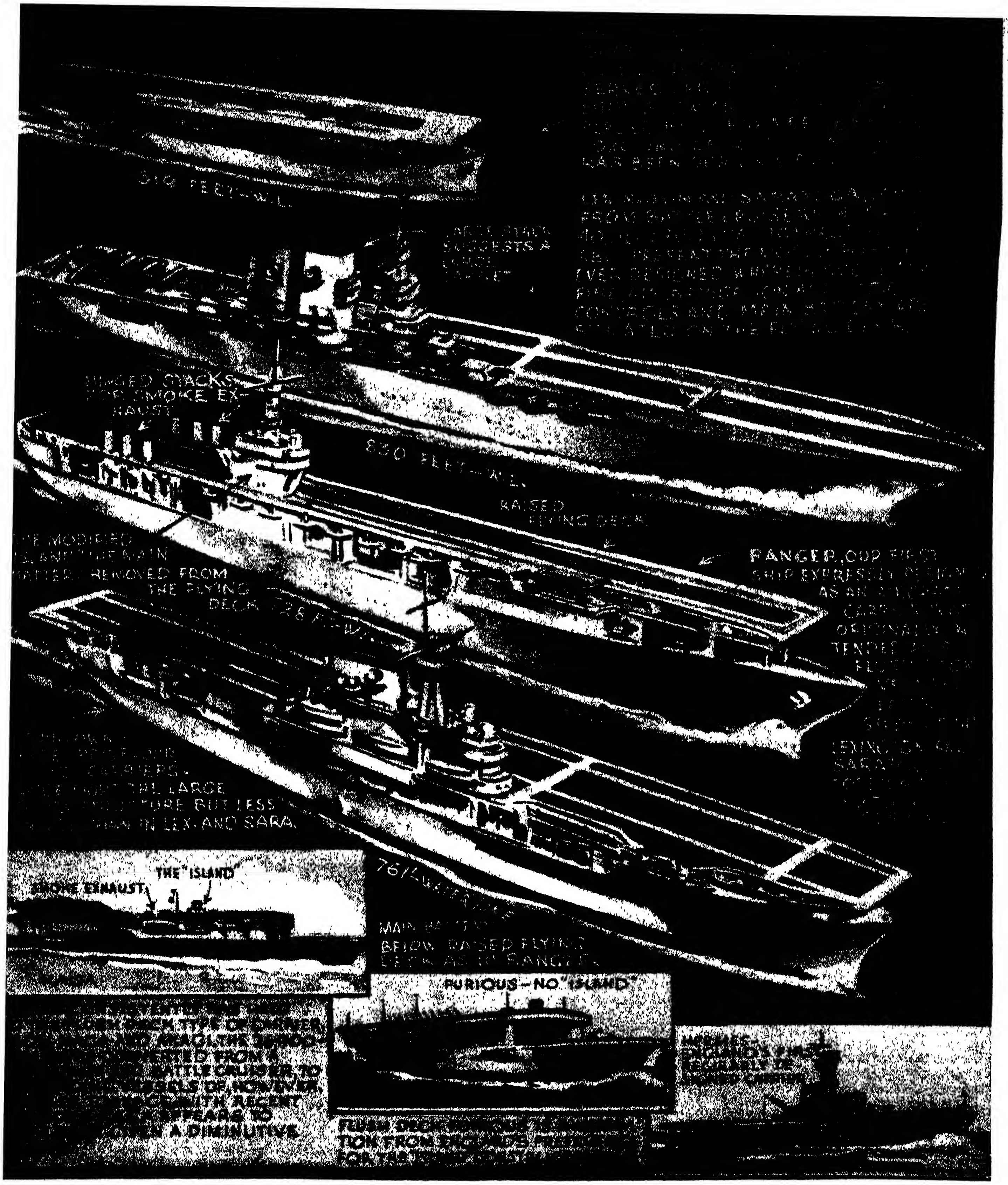
¶Enzymes hold the keys to life and death, by Barclay Moon Newman.

¶Streamlining plants for better agricultural crops, by Keith C. Barrons.

¶China pioneered in invention, but not in modern science. Why? By Rufus Suter.

¶Photo-engraving now produces oilcloth, textiles, wall-paper, by Philip H. Smith.

¶Engineers are converting the Everglades into a land of promise, by R. G. Skerrett.



TREND OF DESIGN IN AIRCRAFT CARRIERS

HOW best adequately to perform all necessary functions on aircraft carriers is the unceasing concern of the naval architect. From the time the old collier *Jupiter* was converted into our first mobile flying field *Langley*, there has been some difference of opinion regarding the placement of navigation and fire control, defensive guns, and smoke stacks. Consequently, *Ranger* was at first planned without an "island" but a small one was added. One important thing that has been learned is that carriers must be designed as such from the keel up.

General view of the sulphur derricks at Grande Ecaille to bring sulphur to the surface by means of the Frasch system

The sulphur plant with sulphur storage vats right center. Background shows marshy nature of terrain

An Industry on Stilts

Industrial City on Useless Tidal Marsh . . . Over 35,000 Piles Support 326,119 Tons . . . Difficult Construction Job in Mud . . . Unique Features

By HOMER S. BURNS
Superintendent of Construction, Freeport Sulphur Company

LITERALLY suspended in air on 35,854 pilings, which vary in length from 40 to 80 feet, an industrial community weighing approximately 652,238,000 pounds has been erected on what a few years ago was considered a useless tidal marsh of the Mississippi River delta. This unusual industrial and engineering feat was accomplished by engineers of the Freeport Sulphur Company in consultation with the J. F. Coleman Engineering Company, of New Orleans, and the J. G. White Engineering Corporation of New York, for the mining of sulphur at what is now Grande Ecaille, Louisiana.

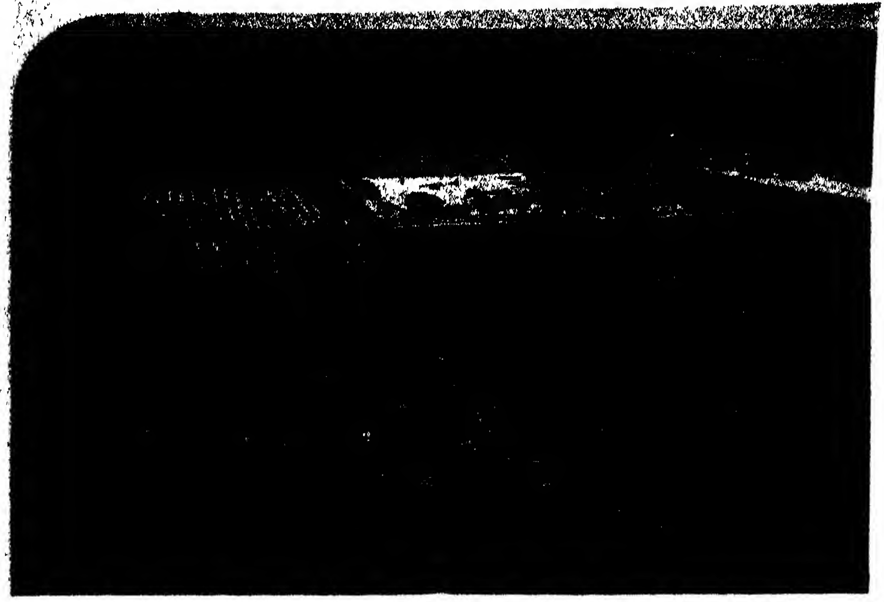
No chapter in the story of sulphur—from its first recognition more than 4000 years ago, to the development of extraordinary processes for its extraction, such as the Frasch hot-water method—is more interesting than the story of this achievement in placing several million dollars' worth of necessary modern equipment in a geographical location which contributed absolutely nothing to the mechanical aspects of the undertaking. Today this plant in operation produces heavy tonnage of sulphur, helping greatly to steady supplies of this element which is widely used in scores of industries.

The Grande Ecaille salt dome is in Plaquemines Parish, Louisiana, 10 miles west of the right descending bank of the Mississippi, 45 miles below New Orleans, and within four miles of the Gulf of Mexico. The terrain is a low, flat, uninhabited area of marsh land, intersected by innumerable shallow lakes and bayous. Except for salt grasses, the region is devoid of vegetation and presents an unobstructed expanse to the vagaries of the winds.

IN July, 1929, prospecting began in this bleak, forsaken area—but for oil, not sulphur. The land was owned by three oil companies and one of these was delegated to do the test drilling. In addition to finding oil, the drills brought sulphur cuttings to the surface from a depth of 1500 feet and more.

The Freeport Sulphur Company acquired the sulphur rights to these swamp lands in 1932, and prospecting was begun immediately. In addition to prospect drilling, a torsion balance survey was made under the supervision of Dr. Donald C. Barton of Houston, Texas, to determine the size, depth, and configuration of the cap-rock area.

While these two methods indicated that there were large quantities of sulphur in the area, there still was no way of knowing, without vast expenditures for plant and equipment, that sulphur could be mined at a profit. It was initial-



Thousands of piles driven into the marshes at Grande Ecaille form the foundations for all plant structures. On these, concrete mats were built to support piers

ly estimated that the cost would amount to millions of dollars and subsequently the actual expenditures boosted the final costs well over 6,000,000 dollars, which was the original estimate.

In the face of pessimistic opinions on the possibility of a plant being built on an almost submerged swamp, the company executives decided that the undertaking was worth the risk. Almost immediately after this decision was reached, actual construction work got under way.

The first difficulty to be surmounted was the job of transporting material to the swamp area. While the salt dome is within ten miles of the Mississippi, there were at that time no practical means of transportation to the location. It was necessary, therefore, to ship materials from Harvey, opposite New Orleans, through the Harvey Canal to Little Barataria Bayou, on through Big Barataria Bayou, Bayou Dupont, Dupree Cut, Cutler Bayou, Bayou St. Denis, across Barataria Lake into Lake Grande Ecaille and thence to the dome, a distance of 70 miles. As the lakes and bayous were shallow, the barging not only was costly, but exceedingly hazardous.

The next difficulty to be overcome was the horde of insects which added greatly to the discomfort of the men. This obstacle was overcome by erecting airplane propellers on automobile motors and blowing the insects out of the area.

The sites for the power plant and auxiliary buildings were marked off away from the dome area to insure freedom from the surface subsidence which was expected to result from the extraction of sulphur by the Frasch system.

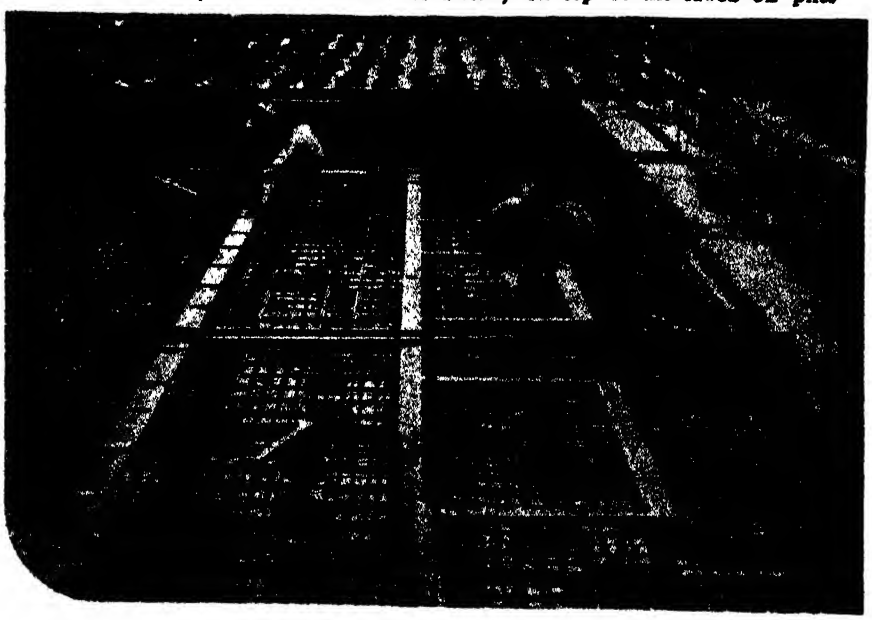
During the prospecting period and after site locations had been selected, the engineering department of the sulphur company prepared and studied several tentative plans for equipping the property. The chief difficulty lay in the selection of the proper foundations. After exhaustive tests, the plan adopted called for heavy reinforced concrete mats supported by piling for the foundations of the buildings, and hydraulically-made fills for the vat foundations and mining area.

Port Sulphur, a site on the Mississippi River accessible by train and highway, was purchased as the supply base. From Port Sulphur to Grande Ecaille, a canal 100 feet wide, nine feet deep, and ten miles long, involving the movement of 2,000,000 cubic yards of dirt, was built to facilitate movement of supplies to the dome.

With transportation simplified, materials began to move into Grande Ecaille by the hundreds of tons. Piling totalling 2,126,301 linear feet, or 403 miles, was shipped in; and other shipments included 4,000,000 board feet of lumber; 200,000 linear feet of pipe from four inches to 42 inches in diameter; ten miles of 33,000-volt power line; five miles of 2300-volt; 15 miles of telephone line; 9102 tons of structural steel; 586 tons of roofing, siding, sashes, and doors; 5832 tons of material and machinery; 19,206 tons of concrete; and 6757 tons of wooden buildings.

More than 8,300,000 tons of dirt were moved, either in building canals or for fills, about half with dipper dredges and the remainder pumped by hydraulic dredges.

The mats on which piers are constructed to support building floors are built of concrete heavily reinforced with steel directly on top of the sawed off piles



FOUNDATION conditions in the Mississippi Valley have been found to vary considerably, usually improving as the river is approached. Soil conditions where pressures up to 1200 pounds per square foot could be used were encountered in various places, while at others it was found this loading would produce prohibitive settlement. Because the soil has virtually no supporting power a short distance from the river, it was decided that structures of any magnitude would have to be supported on piling. During driving and loading tests, it was found that no stratum existed sufficiently close to the surface to be of value for supporting the piling and that only the friction between the soil and the piles could be depended upon.

During driving of the piles it was found that the upper 45 feet of soil offered practically no resistance, the piles almost always penetrating this depth under their own weight before a blow was struck. It was also noted that in spite of the soft character of this soil, it had a tendency to set up within a few hours. Where driving was continuous, a penetration of eight inches per blow was recorded, as against only a half inch pene-

tration from the 10,000-pound hammer after the piling had been allowed to stand partly driven overnight. From these tests, it was decided that 75-foot pilings would carry a safe load limit of eight tons each.

The concrete mats were designed to distribute the load uniformly and to provide adequate strength for any variations in the individual supporting power of the piles, as well as for future requirements. The foundation for the boiler plant alone required 3500 untreated piles, 75 feet long, driven on approximately two-foot eight-inch centers. The firing tanks and the water storage tanks also were built on piling foundations capped with concrete mats.

When it came to construction of the plants, many factors had to be considered—weight, resistance to settlement, high winds, corrosion, and tidal storms. All permanent buildings are constructed of steel with corrugated asbestos roofing and siding. To decrease weight and eliminate corrosion, aluminum bolts and clips of high tensile strength were used for fastenings. Because of the exposed location, the steel frames were designed to withstand winds of 125-mile velocity. Window sash is of galvanized steel, and gutters and downspouts are of aluminum to minimize the effects of corrosion from the salt air.

THE floor of the plant is at an elevation of 12 feet above mean Gulf tide and 11 feet above the surrounding marsh, which was considered by engineers ample to protect it from storms and high tides. The mat itself is only slightly above the marsh, the pilings being cut off about one foot above the water and capped with the thick concrete mat on which piers were constructed to support the plant floor and equipment. The space between the plant floor and the mat is used for water storage.

When the unfavorable location is considered, construction costs were kept relatively low, foundations for auxiliary buildings such as the blacksmith shop, machine shop, and warehouse averaging $2.11 per square foot of floor area.

In addition to the plants, it was necessary to construct a 50,000,000-gallon earthen reservoir for settling the turbid water from the Mississippi before pumping it into the plant. A pipe line approximately nine miles long conveys the water to the plant where storage for 2,000,000 gallons of water was provided.

The weight per square foot of area of a sulphur vat with a 20-foot depth of sulphur averages approximately 1⅛ tons. To prevent excessive settlement, the supporting power of the vat area was increased by 60-foot piling in its bed, placed on four-foot centers.

It is estimated that the total tonnage now suspended in air on piling at this plant is 326,119. Despite this great weight on a foundation entirely of piling driven into marsh land which may seem precariously situated to the layman, the amount of settlement is almost nil after three years of steady operation —an excellent indication that the engineers not only planned well, but also constructed solidly.

Their work, however, did not stop with construction of the plant. They also had to take into consideration living quarters for 200 men, transportation, shipping, and other details which, while they may appear minor now, were major engineering feats at the time.

It was decided that Port Sulphur would be the shipping terminus for the plant. Here were constructed the mine offices, laboratory, and a model industrial village, with a school, community center, parks, and recreational facilities for the employees and their families. Today, Port Sulphur is considered one of the model towns of Louisiana, with a population of 600.

In addition to the foregoing, a dock 1000 feet long was built on the Mississippi River for the accommodation of vessels with a draft of as much as 35 feet.

Material for the plant and commodities for the village now are brought in by boat, by the New Orleans and Lower Coast Railroad, a branch of the Missouri Pacific Railroad System, and by a highway from New Orleans. And by these same facilities, many thousands of tons per month of 99.5 percent pure sulphur are trans-shipped from the Port Sulphur canal to 71 industries throughout the world to find its way, in one form or another, into 32,000 manufactured products in everyday use.

The difficulties faced by these linemen, who are shown stringing power and telephone wires, exemplify those faced in the entire job of building the plant

Even the roads had to be built on stilts. This raised board road on piles leads from the construction office at the water-side to the sulphur domes

Trenching overburden to uncover dinosaur footprints in limestone bed of the Purgatory River, Colorado. (The two holes in the foreground are not footprints)

Dinosaur Trails of Purgatory

By JOHN S. MACCLARY

IN the limestone stream bed of Purgatory River, in southeastern Colorado, the positive record of a Jurassic *day* has been uncovered. There, the almost perfect trails of both carnivorous and herbivorous dinosaurs have been preserved side by side.

In addition to the large round tracks of a quadruped, the limestone contains numerous impressions from the feet of ancient three-toed bipeds. The large round tracks, which average 30 inches in diameter, were made by a monstrous herbivorous dinosaur. The three-toed footprints, 18 inches long and 12 inches wide, are credited to dinosaurs of carnivorous nature. The entire assortment of ancient impressions, apparently, may have been made in the same distant day—possibly within the space of a single hour.

One three-toed trail angles to follow that of the huge four-footed creature, obviously indicating that the carnivorous biped pursued the huge vegetarian. The deliberate gait of the two-footed flesh-eater, whose strides almost uniformly measure 48 inches, gives the impression that the killer felt confident mastery of the situation. Irregular spacing of prints in the four-footed trail may be regarded as evidence that the herbivorous dinosaur was aware of impending conflict, which it did not relish.

The matrix which has preserved the trails of primeval saurian foes is composed of oolitic limestone and the exposure is classified as belonging to the Jurassic period, Mesozoic era. Although succeeding geologic periods left deposits of earth and stone which reached a height of more than 1000 feet above the tracks on the Jurassic beach, the bed of covering shale effectually cushioned the ancient trails—until erosive Purgatory River bared the pages of Nature's diary.

Local cowboys have picked up innumerable fragments of fossilized bones, believed to be portions of dinosaur skeletons. No scientific excavations had been conducted in the Purgatory. In the Colorado Museum of Natural History, in Denver, there are two blocks of track-bearing oolitic limestone from the Purgatory site. "Paleontologists who have viewed the specimens," according to Mr. H. C. Markman, Curator of Geology, "seem to believe the three-toed footprints were made by a variety of dinosaurs yet unknown."

Since the Purgatory tracks exist on land which is privately owned, interested visitors do not barge in and quarry specimens for souvenirs. The writer satisfied the desire for ownership of a dinosaur "foot" by pouring plaster of Paris into the best-preserved footprint that could be found in the Purgatory group. Around that form have been molded in concrete numerous reproductions of the ancient track, creating unusual bird-baths.

Where dinosaurs once sloshed in Jurassic ooze, now is the edge of America's "dust bowl." The Purgatory "badlands" are well-named!

Plaster was poured into the best of the Purgatory River footprints and the hardened "foot" is shown. Beneath it is a reproduction in concrete, made from this plaster copy. It is used as a bird-bath

A close-up photograph of the same trail that is shown in the illustration at the top of the page. These tracks are 12 inches wide and 18 inches long, but the dinosaur's plodding stride was only 48 inches

OUR POINT OF VIEW

A Scientific Art

IF you heed the critics on one side, you'll agree that it is not a science. Another set of critics will make you believe that it's not an art. Perhaps then, photography feeds and grows fat upon criticism; for grow fat it does. At any rate it has grown into an industry to reckon with and is growing faster every day. Don't ask us to tell you how very many millions of dollars are spent upon it annually, how many billions of prints—candid and otherwise—are made.

Probably in your own home you have a little snooper with a flock of lenses (candid variety) and a dark-room. If not, there are probably six in your office and *do* you have the time of your life joshing them, when they proudly, gleefully, exhibit their latest batch of pictures! These are the candid cameramen, the neo-or-something artists. You caustically suggest as their coat of arms a shield with argent bar sinister (for their undercover work) with a lens couchant (the photographer on his head) shooting a field vert with unsuspecting persons rampant, super-sensitive panchromatic films entwined. And then you consign the whole candid tribe to perdition.

But, without boring with oft-repeated details—in too much detail—let's look at the record. This magazine— most others, too—would be poorly illustrated without photographs. History would give but little idea what the man Lincoln was like physically, or Teddy Roosevelt, or General Grant, or McKinley; science could portray only with poor sketches the appearance of germs or a laboratory set-up or a new kind of animal seen in the jungles of Borneo; tens of thousands of acres of land could not be surveyed from the air; manufacturers, engineers, scientists, workers in all walks of life would not be able to show the multitudes how a new product is made, how Boulder Dam was built, how blood flows in the veins of a rabbit's ear—without photography all those vitally concerned and those merely interested in these things for the sake of knowledge would not be so enlightened.

That photography has enormous value goes without saying. Whether it is an art or a science may be argued by the hotheads. We believe that it is both. Certainly somewhere back down the line it sprang from science and its developments continue to emanate from the laboratories of serious scientific researchers. Just as certainly somewhere in the future it is going to make an important place for itself in the world of art. Judging from the photographs submitted in our contest, which is discussed on another page of this issue, it has won that place already. The thing photography must do now is to gain full *recognition* as an art.

Pass This Bill

ONE of the strangest traits of the American people is its ostrich-attitude toward many things of great import, and then its hysterical clamor when some tragedy results. We look on apathetically, if we take the time from our little personal interests or pleasures to look at all, while someone with more foresight and gumption expends much effort to save us from ourselves. Immediately a disaster falls, however, we lift the roof with our cries of condemnation of everybody and everything for having let it happen to us.

This has been the case with the attempted revision of the Food and Drugs Act. That Act has a number of loopholes, as Senator Royal S. Copeland explains on another page—loopholes that have permitted the sale of harmful drugs that have caused the deaths of many people. The fault lies in the law, not on those who administer it; for it is truly a bustle-and-ruffle law doing the very best it can in a streamlined age.

For several years a strenuous effort has been made to pass a new Act which would close the loopholes and give the Food and Drug Administration effective power to prevent the advertising and sale of dangerous drugs and untruthful advertising of others. The public has been indifferent. Actually, there has been some strong opposition. Yet when an elixir of sulfanilamide kills more than 70 people, the same public wants to know why sale of it was permitted!

There will, however, be stronger support, because of those deaths, for the revised Food and Drugs Act, Bill S. 5, which is now, or shortly will be, before Congress for passage. It may have defects. It may have loopholes which should be plugged. Perhaps, even, certain of its provisions will work too great a hardship on honest businesses. Congress will do its best to take care of any and all of these, but help will be needed, help from an articulate electorate. We cannot urge too strongly, therefore, that you write your Congressman about this Act. Favor it, criticize it, make suggestions, but write. Properly amended, it should pass so that your wife, your mother, your sister may not court disaster every time they purchase a cosmetic, or that worse does not befall you or your family because of loopholes in an out-dated law.

Doublfeaturitis

ARE you a victim of doublfeaturitis? Are your legs cramped; do you break out in a nervous perspiration, shift uneasily in your chair in an endeavor to find a spot that does not ache as a result of prolonged pressure; do your eyes twitch, your fingers pluck uneasily at the buttons on your vest? Clip these questions, take them with you the next time you attend a movie, and if you can answer all of them truthfully in the affirmative, then you are a victim of doublfeaturitis.

Basing their action on the erroneous assumption that, if one good movie is worth the price of admission then two mediocre movies should be better value for the same price, motion-picture exhibitors throughout the country have gone in whole-heartedly for double—in some cases even triple and quadruple—feature programs. By so doing, they have made necessary the mass production of a large number of cheaply made features, resulting in a flood of movies that, to say the least, insult the intelligence of a large proportion of the movie going public. True, some of the larger producers are turning out movies that are a credit to the institution and art. But such films involve huge investments, take long months to produce. They cannot be turned out in sufficient quantities nor rented to exhibitors at a price low enough to meet the demand for double feature programs.

But, regardless of production problems, what can the victim of doublfeaturitis do to alleviate his distress? He can do the same thing that he did not so long ago regarding smut on the screen. He can protest, and, as soon as his collective protests are loud enough and vehement enough, results will follow.

You victims of doublfeaturitis must arise en masse. Make sure that your local exhibitors are told positively and often about your distaste for interminable and mediocre programs. Use your daily papers to spread the alarm. Then watch the producers and exhibitors, when they feel the pressure in their treasuries, begin to offer good single features with a variety of succulent short subjects. The future of the disease is in your hands. Arise and strike before it becomes chronic!

EDITORIAL anticipation, based in part on previous experiences with "ticklish" articles, suggests that the accompanying one will fall in that category. It should not, however —if readers will read it closely, read *all* of it, and judge it solely on the basis of what is stated in it. There is a human tendency to color controversial discussions by unconsciously pouring in with their content various points of view brought from previous sources of belief. Too often these beliefs are from erroneous tradition or even old wives' tales.

As the reader will see, the bottom brick of the pile leading sometimes to full paranoia is the feeling that the subject should have amounted to more than he did. How irrational this is may be shown by a study of Nature. To only a few individuals does she happen to grant unusual abilities, a matter evidently of genetics and one that lies beyond the responsibility and control of the individual. Hence, if one has failed to attain to great ends there is plenty of company. Incidentally, our American over-worship of the god Success may have something to do with our high insanity rate.

Taken solely on the basis of its contents the accompanying article should offend none and alarm but few, while it ought to reassure and assist many. It may also prove useful in enabling the individual to estimate some of the numerous public figures of our troublous times, not omitting some of the heads of governments.

The choice of illustrations for this article must not be awarded undue significance. Because psychology is not an exact science there is no proof positive that any of these characters were of the paranoid type. It is certain that, if they were, they were so to dissimilar degrees. Also, had it been desired to select types that go further into the paranoid personality—often into sheer paranoid insanity—illustrations of Ivan the Terrible, some of the Borgias and some of the Roman emperors could have been chosen. This might, however, have done injustice to the others, since some readers might then make the wrong inferences.—*The Editor.*

THE PARANOID PERSONALITY

Merely our Everyday Traits Exaggerated . . . At its Roots is the Unwillingness to Admit Inferiority . . . How to Avoid it, How it Grows, How to Deal with it

By PAUL POPENOE, Sc.D.
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DRIVING down from the White House, President James A. Garfield entered the railway station to take a train for Boston. He was looking forward to a pleasant vacation, in the course of which he would attend Commencement exercises at his alma mater, Williams College.

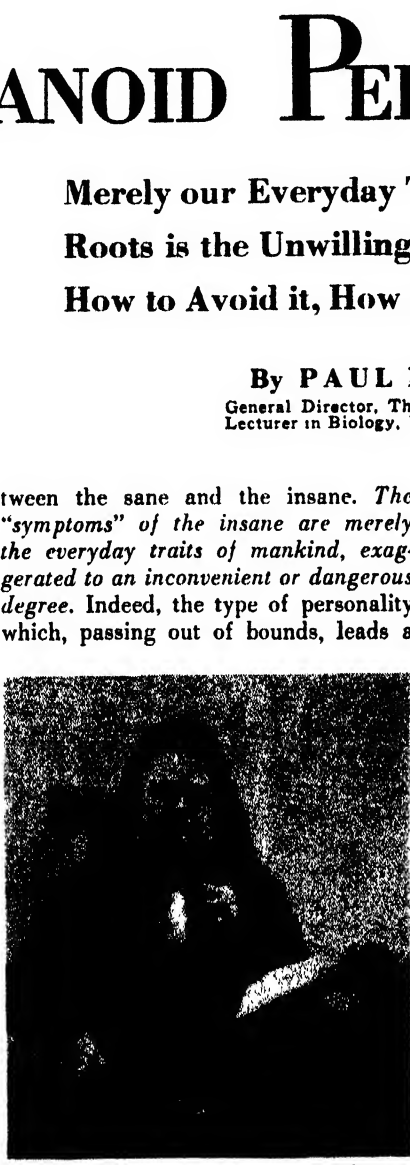
From the spectators, one man pushed forward. There were two shots from a revolver, and the president slumped into the arms of his Secretary of State, James G. Blaine, with whom he had been walking.

The murderer gave his name as Charles J. Guiteau and explained his motives at once. "I killed him as a political necessity under Divine pressure," he announced, "after two weeks of earnest prayer."

HOMELESS, penniless, syphilitic, a failure in life from start to finish, Guiteau considered himself a great man, a political power whose campaign activity had done much to elect the former canal boy to the presidency. It transpired that this political activity consisted mainly of a speech delivered once to a few dozen negroes. But Guiteau felt that he was entitled to office as a reward of his exertions. He wanted to be consul-general in Paris. When the president proved "ungrateful," he decided that it was for the good of all concerned that the "stalwart" vice-president, Chester A. Arthur, should take his place.

"Guiteau was crazy," you will remark; and you may remember that you have heard him described as a paranoiac.

Just because he is such an extreme case he provides a good illustration of the fact, axiomatic in psychology but difficult for the public to grasp, that there is no sharp line of demarcation between the sane and the insane. *The "symptoms" of the insane are merely the everyday traits of mankind, exaggerated to an inconvenient or dangerous degree.* Indeed, the type of personality which, passing out of bounds, leads a



Carry Nation, the saloon wrecker, typical of the crusading makeup

Guiteau to the gallows, is the same type of personality which, kept within bounds, is at least partly responsible for the achievements of some of the world's greatest men.

Two factors stand out in a study of Guiteau: first, his unwarranted conceit, which led him to think himself an important person entitled to reward, and, second, his unwarranted suspicion, which led him to think that the president was doing him an injustice.

These two factors, conceit and suspicion, are the soil in which the paranoid personality has its roots. But the seed is found farther back in a feeling of inferiority or failure and an unwillingness to admit the cause.

This cause itself may be anything at all—in one instance perhaps a sexual inadequacy, as the Freudian psychoanalysts assert, in another perhaps a shriveled arm, as with the ex-Kaiser.

SO far as the complex interplay of forces in life can be simplified into a diagram, nine steps lead to the development of a paranoid tendency. They are easy to follow, one after another. Fortunately, though all of us start down this path, common sense prevents most of us from going to the end. The steps are about as follows:

1. Every man wants to succeed in the world, to amount to something, to attain power and recognition.

2. For some reason, John Doe fails to attain the position in life which he thinks he ought to have.

3. This results in a feeling of dissatisfaction, weakness, mortification, or shame.

4. Such a feeling is uncomfortable and he seeks to be rid of it.

5. He is not sufficiently indifferent to ascribe the failure to fate; still less has he the strength of character to admit, even to himself, that it is "all his own fault."

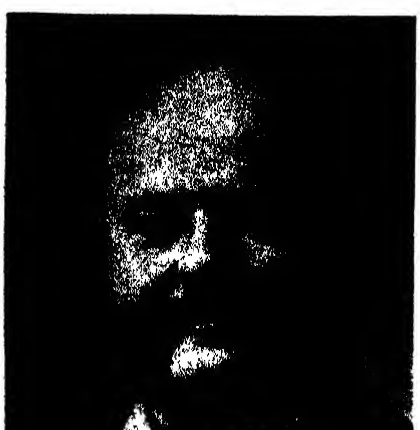
6. He therefore seeks to blame it on someone else—on his environment. Since he cannot admit that his failure is just, this requires him to believe that someone is unjustly persecuting him.

7. If he is being persecuted, it must be because the enemy is afraid of him or jealous of him, for no one would take the trouble to persecute a man who did not amount to anything. By easy steps, then, he convinces himself that he is a very superior person: the more he fails, the more it is proof that someone is opposing him; the more he is opposed, the more it is proof that he must be a great man to excite such formidable opposition.

8. This feeling of grandeur compensates for his unconscious feeling that he is a failure and gives him a quasi-rational and highly satisfying explanation for the suspicion which leads him to believe he is being persecuted.

9. Little by little these various ideas become established in his mind as an organized system, and if he goes this far John Doe has become a full-blown and probably insane paranoid.

Whether delusions of grandeur or delusions of persecution are more fully developed in the insane paranoid seems to depend partly on his natural temperament. If your man is an optimist, he will



Anthony Comstock, over-zealous crusader against indecent matter

go in for grandeur. The grotesque exaggerations of the feeling of self-esteem, which one encounters in mental hospitals, are well-known. "Don't call me Henry," a patient requests. "My name used to be Henry but I've been promoted. I was King Henry for a while but now I'm God Almighty Lord Jehovah."

If, on the other hand, your man is a pessimist, the idea of persecution is likely to be most prominent, and eventually to take the form of a well-organized and logic-tight system of delusions. Frequently the patient thinks that some powerful and far-flung secret society is after him —it may be the Masons or the Knights of Columbus or the Ku Klux Klan or the Silver Shirts or the B'nai B'rith, according to what his own contrary views happen to be. On the principle that there is safety in numbers, it is a good thing to have the paranoid's suspicions directed against a body of 100,000 men instead of against one individual. Unfortunately, however, you never can tell when he will pick out one individual from the mass, as an envoy who has been particularly designated by the Inner Council to "get" him and who therefore has to be liquidated. An insane paranoid is always a potential criminal.

SINCE any trait is more easily recognized when it appears in an exaggerated form than when it is at a minimum, the paranoid personality was first identified *in its extreme development* among the insane; just as I have started this discussion with the example of Guiteau. Nearly half a century ago Emil Kraepelin, the great German psychiatrist, described paranoia as a distinct form of mental disease, and the term "paranoiac" became current. This word has largely fallen into disuse in recent psychiatry. Paranoid tendencies are now recognized as one of the common components of the human personality. Emphasis is shifted from the insane to the normal. Most of the "paranoiacs" or insane paranoids are now diagnosed as victims of dementia praecox, the commonest mental disease and in many ways the one most serious disease of mankind. On the other hand, the great bulk of the paranoids are not insane—*they are as normal as you and I.*

Obviously, there must be all grades of this personality. One can find a complete series of transitions, from the momentary feeling any one of us may legitimately have that he has been done an injustice, his merits not properly recognized, to the complete mental breakdown that one finds in the psychopathic hospitals or in a criminal like Guiteau.

It will be interesting to look for these paranoid tendencies in some of the great men of history. Remember that conceit and suspicion in varying degrees are certain to be present in the paranoid. Conceit may take the form of an exaggerated ego but it is often disguised in the average man as a strong feeling of self-righteousness. Suspicion is often disguised as a very strong resistance to accepting other people's opinions.

Napoleon is a striking illustration. His poverty, his family situation, his alien appearance in France, perhaps also his short stature, all contributed to give him a sense of inferiority. He reacted to this by a boundless self-esteem, and by a feeling, which grew on him with the years, that he was surrounded by enemies and could trust no one. On the other hand, his constant suspicion that his guards at St. Helena were trying to poison or destroy him may have been largely pretense, for he was a poser who did not know the meaning of sincerity; but paranoid tendencies can be recognized at any stage of his life.

Woodrow Wilson furnishes an exam-

Emanuel Swedenborg, a Swedish scientist who turned mystic. He heard mysterious conversations and experienced extraordinary visions

ple closer home. As a child he did not know how to get along with others, and this difficulty followed him to the day of his death. He could not get along with his faculty and trustees at Princeton or with his cabinet and Congress at Washington. During his illness the Secretary of State, Robert Lansing, wanted to see business carried on and queried whether the vice-president might not sign routine documents. Wilson saw in this a plot against himself and demanded the secretary's resignation. He broke with almost every intimate, one after another—even with Colonel House. His last years were passed in the shadow of a cloud of suspicion, resentment, and bitterness.

IN earlier American history John Randolph, John C. Calhoun, John Brown, and Charles Sumner come promptly to mind. The Adams family of Massachusetts appears to have had its full share of paranoid traits. As a fact, this type of personality tends to run in families, and there is probably some biological basis for this, but studies do not yet prove how far its development is due to constitutional factors and how far to childhood experience, or to mere imitation.

A candid examination would show, I believe, that many lawyers and politicians are paranoids. One may be helped to succeed in these two interrelated professions by aggressiveness, stubbornness, determination, and self-esteem. In

the case of politicians, an exaggerated idea of one's own importance is probably an asset, a tendency to blame one's failures on other people is a habit, and tendencies toward both fault-finding and revenge are so common as to make it appear that they must be useful to their possessors. (Another type of politician, however, succeeds for the opposite reason—through his great deficiency in paranoid traits. He is the glad-hander, the "joiner," the man whose main objects in life are never to make an enemy, never to espouse an unpopular cause, but to keep his ear to the ground and be "loyal to his friends.")

But the lawyers and office-seekers have no monopoly on paranoid traits. You can find them in any direction you may look. They are not absent, for example, among many religious "reformers," particularly those belonging to some of the more fanatical fundamentalist sects.

Parenthetically, Guiteau proclaimed, "I'm a lawyer, a theologian, and a politician!"

A STRIKING illustration from the scientific world is furnished by Gregor Johann Mendel, the monk who is universally recognized as having found the long-sought clue to the riddle of heredity. Born a poor peasant's son in an Austrian village (now in Czechoslovakia), he went into a religious order merely because he could not afford to get an education in any other way, and carried on his plant-breeding experiments while teaching science in the local high school. He was made abbot of the monastery—a wealthy and influential one even by the standards of a country where the church has seldom lacked wealth and influence. Soon he started a fight with the government on a question of taxation. Single-handed, and against the judgment of his associates, he defied the power of the state, which retaliated by depriving the order of its most productive properties, one by one. He shut himself up in his palatial headquarters and alleged that his enemies were trying to poison him in order to get him out of the way. His death half a century ago ended the sort of impossible situation that is bound to arise when an irresistible force meets an immovable object; and his successor lost no time in arranging a satisfactory compromise with the government.

In the light of these illustrations, it should be easy to recognize that the paranoid personality is not found merely among the derelicts and discards of society—that it often accompanies outstanding intellectual qualities. Analysis of a large number of normal, everyday cases would show that such traits as the following are likely to be found in the paranoid:

1. Excessive pride, haughtiness, conceit, self-righteousness, and disdain of others.

2. Sensitiveness to what others think about him; uneasy about this.

3. Strong, stubborn, propagandistic, opinionated, resistant, biased and prejudiced—"a one-track mind."

4. Rigid and unadaptable; not willing or able to discuss controversial subjects freely; can't make concessions or compromises easily or gracefully.

5. Suspicious and revengeful; remembers slights and holds grudges indefinitely; nurses quarrels instead of forgiving easily.

6. Given to scolding, nagging, complaining, and fault-finding. Over-critical, exacting, jealous, and often intolerant.

7. Aggressive in his own defense; becomes abusive or quarrelsome on slight provocation; seeks for grievances and exaggerates them; "is looking for trouble."

No one person will show all these traits in equal degree. Every one of us will show some of them. The paranoid will show a number of them. If any man has at least half of these to a pronounced degree, it will probably be accurate to class him as a paranoid.

Sir Isaac Newton, greatest of all intellects but a "difficult" personality

Thad Stevens, a noted political leader who, opposing Lincoln, demanded vengeful treatment of the South after the close of the Civil War

When any person encounters an emotional obstacle in life, he may take one of three different courses: (1) advance and attack; (2) surrender, "lie down and take it", just "quit"; or (3) run away. The individual who reacts in the first manner is the only one who is likely to become paranoid; the other two types will develop other difficulties of personality, but not paranoid tendencies. Hence, the trait No. 7 above, aggressiveness, is an essential part of the picture.

Men are more likely to become paranoid than are women, because aggressiveness is typically a male, not a female, characteristic.

A REVIEW of the seven kinds of traits I have mentioned above as likely to be found in paranoids will show that many of them are, in a moderate degree, of great value and responsible for much of the world's progress. Consider a man who lacks them altogether: among other things, he is likely to be weak and easily influenced, wanting in persistence, determination, and a willingness to stand up for his rights or those of anyone else. No one should be worried, therefore, if he finds on self-analysis that he possesses some of the constituent parts of a paranoid personality. Perhaps he has reason to congratulate himself. Perhaps he would rather be Napoleon or Woodrow Wilson than to be Warren G. Harding, who appears to have been notably deficient in paranoid traits and who might have left a greater name in history had he possessed more of the paranoid's strong convictions and willingness to fight for them.

But, at least, one must take care that one keeps the paranoid traits in balance, uses them constructively, and suppresses at the same time their most annoying manifestations such as the tendency to continual fault-finding.

Any community is fortunate to have a few intelligent, influential, socially-minded, and wealthy paranoids who will be duly suspicious of demagogs, constantly alert to expose injustice and correct wrong-doing, and ready to set themselves against unwise measures, no matter how popular.

On the other hand, the paranoid who gets the worst rather than the best of the qualities that inhere in that type of personality is likely to be a perennial nuisance. He may be a harmless one, haunting the courthouse and seeking justice in some long-continued litigation or for some, perhaps imaginary, injury. He may be an inventor, trying to protect his perpetual-motion machine from the strategies of his enemies who are trying to steal the secret. He may be a more prosaic trouble-maker in the organization to which he belongs. The

business establishment, shop, or factory which does not have at least one paranoid employee, continually complaining and stirring up dissension, may consider itself lucky. Employees who do not have a paranoid boss are likewise entitled to congratulate themselves.

Some of the worst types of paranoids thrive in times of turmoil. When the public is confused, lacking both direction and discrimination, the energy, self-assurance, and perhaps unscrupulousness of the paranoid give him an advantage. Hence every depression, every period of social or industrial unrest, every revolution, is likely to bring them to the fore and land them, for the time being at least, in places of authority. It is not necessary to go back to the French Revolution; those who are familiar with the popular revolts in Europe after the World War will think of abundant illustrations. Indeed, the contemporary newspaper reader will probably have no difficulty in identifying some of the prominent actors on the world's stage today, as motivated by this type of mental mechanism.

Bad enough as chairman of a grievance committee, the paranoid sometimes becomes intolerable as a husband or wife. One need but think back over the seven paranoid characteristics listed above, to realize how hard they might be to live with, day after day. Sometimes the mate appears to become paranoid too, merely by "infection" or "induction."

HOW should one deal with a paranoid?

Psychiatrists testify that it is a hard job, the extremes being considered incurable. But in the normal range, as for example, between husband and wife or employer and employee, they would probably agree on the following:

1. It is of no use to argue. Opposition merely intensifies the paranoid trend.

2. You must start from his premises and, while appearing to agree with him on these, must try to carry him to other conclusions. To illustrate this by citing the extreme case once more, it would doubtless have been useless to argue with Guiteau that he was not a great man and that he deserved nothing from the president. He would merely have added you to the list of his enemies. But you might have assumed that he was a great and deserving politician and have helped him plan a campaign which would have kept him busy and given him more permanent satisfaction than did the assassination.

3. In other words, you must help him to get self-assertion in a reasonable rather than an unreasonable way. He really needs encouragement, not discipline. He is fighting because he feels threatened or menaced. The fighting tendency which he manifests is not wholly bad; it is one of the most deeply rooted biological tendencies. Not suppression but re-education and re-direction are required.

It is even more important for all of us to understand how we ourselves can keep from drifting into an unwholesome paranoid outlook on life. To build up such an attitude is far too easy—the ingredients are present everywhere.

In the first place, everyone has some feeling of inferiority. We grow up with it from childhood, when we are daily confronted by our own weakness and dependence on those who are stronger than ourselves. Throughout life, there are always things we should like to do, which we attempt unsuccessfully. If a man has a proper realization of his own limitations and a correct understanding of human nature, this sense of inferiority will not make any trouble for him; rather, it will keep him out of trouble, for he will not try to do things that are beyond his capacity. Personality analysis, vocational guidance, tests of temperament and intelligence—all the resources of science should be used. They are a great help to realistic adjustment in life, and should be part of the routine of high-school education.

Woodrow Wilson, who even broke with his fidus Achates, Col. House

Clemenceau, the "Tiger," domineered even over his allies at Verseilles, forcing a short-sighted peace

If an abnormal feeling of inferiority is avoided, an abnormal feeling of conceit will probably be escaped, for the latter is usually an attempt to compensate for the former. One who is becoming too self-centered must force himself to take a more active interest in other people.

Finally, suspicion must be abandoned, and this again requires better mental hygiene for a large part of the population. Unless one stops to think about it, one will not realize how easy it is to form groundless suspicions. Do you remember the first time you appeared in public in a dress-suit? You thought everyone in the room was looking at you and commenting on you. As a fact, probably no one paid the slightest attention to you; but you yourself were uncomfortable and projected this feeling on others.

Some day when you feel particularly calm and contented, think over your past life and see how you have reacted to disappointments and defeats. If you have tended to blame others—to think you failed of promotion because "the boss had it in for you" or because the boss's wife didn't like your wife—it is well to be on your guard. Introverts are somewhat more likely to develop unhealthful paranoid ideas than are extraverts, because they are normally more concerned with themselves and brood more over their troubles; but they have no monopoly on this mechanism. Some of the conspicuous paranoids are marked extraverts.

THE dangerous thing about a paranoid trend is that it is so satisfying! No one wants to be a failure; and if one fails, nothing could be more consoling than to believe that one is really a great man thwarted by sinister and powerful forces that are beyond control. Sound mental hygiene will begin by teaching children not to blame other people for their difficulties, and will carry them through life with a good mental balance. This implies continuous adjustment, varied reactions, and an enthusiasm for living. Such habits of life will prevent the onset of many difficulties—paranoid tendencies are only one of them.

The paranoid personality, in conclusion, is a common one and when properly controlled may be a very useful one. But it gets out of control too easily. "Knowledge is power," as the advertisements of encyclopedias advise us; and a knowledge of the origin and manifestations of paranoid feelings will enable anyone to live his own life more successfully and to get along better with those around him.

THE SCIENCE OF

(In Two Parts—Part One)

By SIDNEY J. FRENCH
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NO one doubts today that we live in an age of alloys, for every day marks the birth of some new alloy with particularly useful qualities. We have become accustomed to reading about alloy trains, alloy aircraft, alloy trimmings, and alloy gadgets. Yet, it is surprising to know that until recently the whole process of alloy making has been a shot in the dark, a cut and try process. Two melted metals were mixed together and allowed to cool, sometimes rapidly, sometimes slowly. The result was an alloy. But, like the genius born of mediocre parents, the alloy often possessed unusual qualities, resembling neither parent. There was truly no Mendelian law of inheritance in alloying.

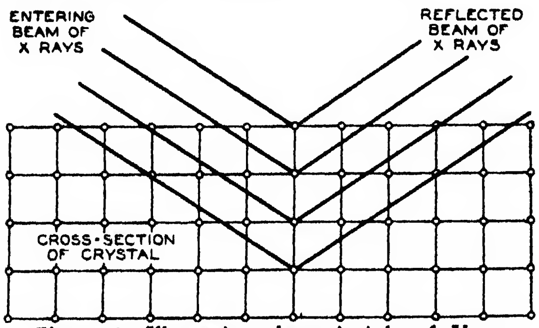


Figure 1: **Illustrating the principle of X-ray analysis of crystals. Atoms reflect the light**

THE first man who mixed together melted copper and nickel in the proportion of 3 to 1 must have been vastly surprised to obtain an alloy which had the luster of nickel alone and showed no evidence of the presence of copper. Yet this alloy was much harder than either copper or nickel alone. So it is today that we have our nickel coins composed largely of copper, and the very useful Monel metal resembling nickel but composed largely of copper. How can it happen that in mixing copper and zinc in certain proportions we get a soft brass easily machined and yet, by changing the proportions only by a few percent, we obtain a brass so hard that it cannot be machined? One type conducts electricity readily, the other, poorly. How does it happen that very soft lead can be hardened by the addition of 1 percent of arsenic? Pure iron is soft and malleable; the addition of from 0.5 to 3 percent of carbon gives tough, hard steels. Tin melts some 200 degrees above the boiling point of water while lead, bismuth, and cadmium melt at even higher temperatures, yet an alloy of these four metals is known which melts readily in hot water. And if indium is added to them an alloy is obtained melting slightly above body temperature. Truly, the domain of alloys has been a veritable Alice in Wonderland where each new turn carried its own surprise. Prediction was useless, for there were few rules to predict by. It was all a matter of try and discover. When a useful alloy was unearthed by this method, the experimenters were content.

Today, however, new rules are creeping into the alloy-making game, and we can begin to predict with some little certainty what kind of alloy will be produced when two or more melted metals are mixed in certain proportions. We are now in the science of alloys about where we were in the science of chemical combination a century and a half ago. But our progress is being greatly hastened by our newer tools.

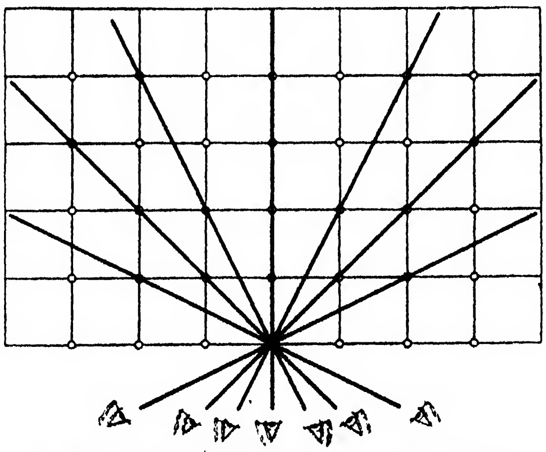


Figure 2: **Lines formed by the regular spacing of objects, as seen by the eye at different angles**

Before we can know what gives alloys their unusual properties we must know what is inside of them. We must study them as we study human anatomy, as we study the works of a fine watch, as we study the structure of a beautiful painting: we must analyze the alloy. For many years we did this by carefully polishing the surface of the alloy, then etching it with acid. The acid, attacking the joints between minute crystals of metal, set the crystals up in relief. With a high-powered microscope the crystal structure could be seen or photographed. This in turn gave evidence of the type of alloy present, and the percentage of each metal present.

The story is told of an unlettered workman who, through long experience, could look at a cut section of a particular alloy and state the percentage composition so accurately that the laboratory soon quit checking his figures.

But this type of analysis is still an external affair. We are still on the outside of the alloy attempting to look in. We are judging the watch by its tick; we must go deeper still—we must go to the atom itself for our answers and no microscope, however powerful, will do for such a purpose. How can we hope to see inside the metal, to see the very atoms when they are of such size that it would take a number of them far greater than the entire population of the United States to make a row one inch in length. Yet, within the past decade or more we have been able by indirect means to do just that thing—to see the atoms, or at least to see the positions they occupy, and to measure their relative sizes. This remarkable achievement has come about through the happy thought of using X rays. Because of their remarkably short

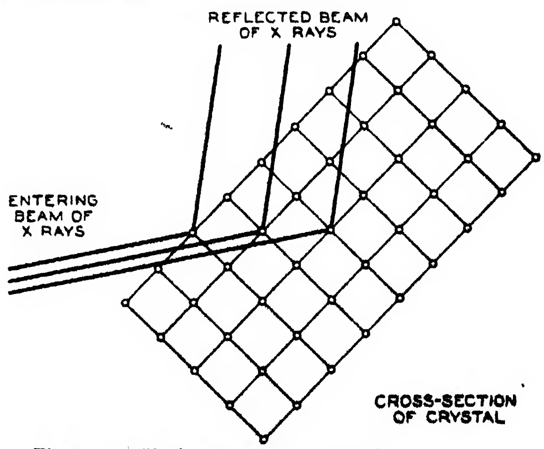


Figure 3: **If the crystal is turned, the X rays are reflected from different layers of atoms**

Alloy Building

Ours is the Alloy Age . . . Alloy Making Today is No Longer, As Once, a Shot in the Dark . . . New Rules in the Alloy Game . . . How We Ask the Atom

wave-lengths, X rays will penetrate flesh and, to a lesser extent, bones, and metals. Not only that, but just as light can be reflected from a mirror, so X rays are reflected from a metal surface. To the X ray the metal acts as if it were a series of polished screens one below the other. Some of the rays are reflected from the top screen, some from the next screen and so on to a relatively considerable depth (Figure 1). Instead of having the opaque or solid surface we imagine it to have, therefore, the metal is full of openings, openings too small for ordinary light to penetrate but large enough to admit the X rays.

A particular X ray will then penetrate the metal until it strikes an atom, either on the top layer or beneath, whereupon it will be reflected. By placing a photographic plate in the proper position, we can, in a sense, take reflected pictures of these atom layers. The details of this process are somewhat mathematical and involve a knowledge of the nature of waves. We need not concern ourselves with such details, beyond noting that this process, properly worked out, gives us the arrangement of the atoms in the metal or alloy and gives us, further, a measure of the distances between rows of atoms. [The theory was explained in detail in Scientific American, January, 1931.—*Ed.*] We shall have more of this later.

No one with the least observant eye has failed to notice the many and orderly rows of corn in a well planted cornfield. As we stroll past the field, we note not only the rows at right angles to the road but many others running off at various diagonals. From each point of view are seen serried rows lined up in orderly fashion. But the distance between plants is different for each of the many lines of sight, just as in Figure 2.

The reflected X ray tells a similar story for the structure of a metal. As the metal under observation is moved on a pivot to present different faces to the beam of X rays, different layers or rows of atoms become the reflecting screen (Figure 3). We are in a sense walking past the crystal and gazing down different lines of atoms. Of course, the analogy to a cornfield is not quite correct, for the crystal is a three-dimensioned affair while the cornfield may be said to have but two dimensions.

When we have found all of these planes of atoms in the crystal and have determined the distances between them by means of a simple mathematical formula, we know the position of every atom in the crystal. What do we find—atoms scattered like an unorganized mob, or atoms lined up in orderly battalions? It is the latter, of course. The atoms are the soldiers of picked battalions on parade. Thus, by means of our X-ray probes we may study the interior of metals and alloys to determine their arrangement. But this, of course, does not answer our questions about the unusual properties of alloys. It merely gives us a starting point in the attack.

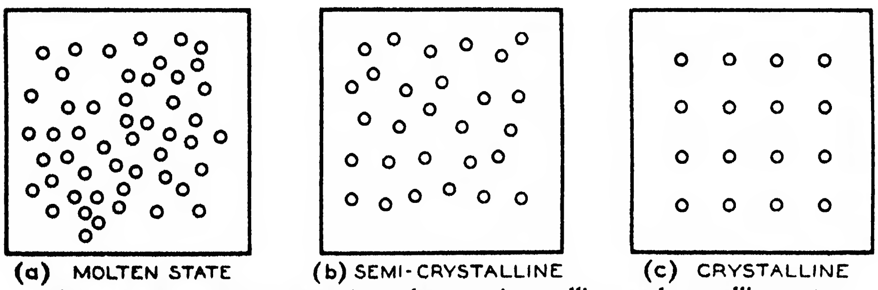


Figure 4: **Atom arrangement in molten, semi-crystalline, and crystalline states**

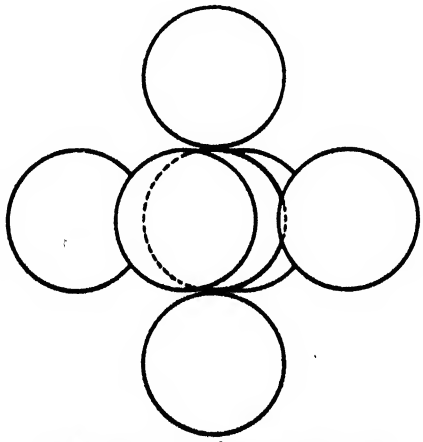


Figure 5: **In the cubic lattice arrangement the central ball is in contact with six surrounding balls**

Before passing on to the types of crystal structure we may well consider what happens to the atom when a melted metal freezes or solidifies. In the melted state, we may imagine the atoms to be swarming about like the members of an angry mob. There is no order, but the greatest disorder. Each fellow is attracted to his neighbors but moves about from group to group. As the temperature falls, the movement decreases and the atoms begin to fall into regular lines; some still moving about, to be sure, but with sluggish motions. When the freezing process is complete the mob has disappeared and in its place we have the orderly battalions of atoms, each atom in a fixed position. This is the crystal of metal. But suppose we cool the metal very suddenly. Atoms do not have time to get into their regular line-up and we have a semi-crystalline metal the properties of which are quite unlike those of the crystal (Figure 4, *b*). This is tempering. When such a semi-crystal is heated up close to its melting point the misplaced atoms drawn by their organized neighbors begin a slow migration into proper position and the metal becomes more crystalline. It begins to lose its temper.

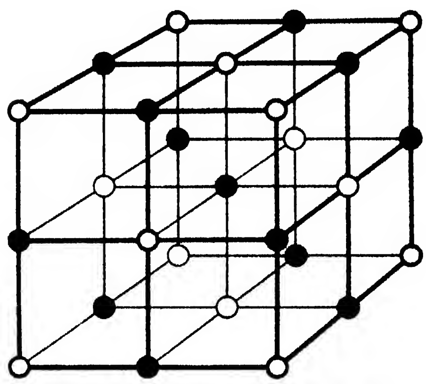
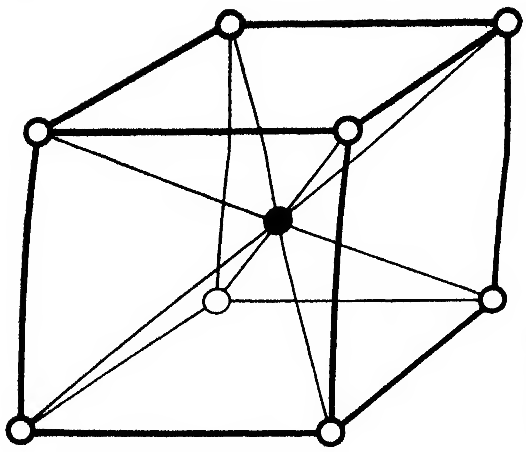
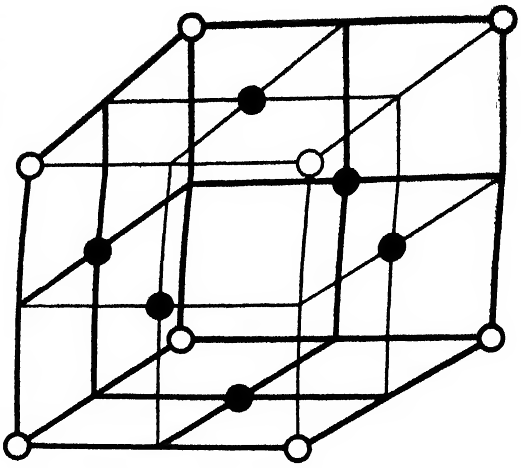


Figure 6: **Cubic lattice. One central ball attached to six white balls**

SOME materials, such as glass, become so viscous before they freeze that the atoms cannot get into line and we have a non-crystalline material sometimes called a supercooled liquid. Yet, even in glass the atoms are slowly migrating into place over periods of many years, so that old glass may become quite brittle or crystalline.



Left, Figure 7: **In the body-centered lattice each ball is held to eight neighbors. (Balls, of course, merely *represent* atoms—are not models)**



Right, Figure 8: **Face-centered crystal lattice. Circles in black are in the centers of the faces of the cubes, as shown**

Though it might be thought that there would be myriads of forms and shapes in which metals might crystallize, these all resolve down to a few simple types, of which the three, called respectively cubic, body-centered, and face-centered lattices, are by far the most common. To visualize these we may imagine shaking up a number of baseballs in a barrel. The balls would take up a more or less orderly arrangement such that one ball would be touching and be surrounded by several others. The simplest form is that in which one ball is surrounded by six others, one above, one below, and one on each of four sides. This arrangement, called the cubic lattice, is shown in Figure 5. A better idea of this structure is obtained by making the balls smaller and connecting them with lines, as is shown in Figure 6. Here it is noted that the structure is a continuous one, the center ball being attached to six neighbors; and if the structure were continued, each interior ball would be attached to six neighbors. The simplest section of this structure is a simple cube with a ball at each corner.

IN the body-centered lattice, each ball is held to eight neighbors, as is illustrated in Figure 7. And in the face-centered lattice each ball has 12 near neighbors (Figure 8). The relationship is, however, difficult to see without the aid of a model. Most pure metals crystallize on one of these three patterns.

Thus far we have said little or nothing about the relative sizes of the atoms or about their other characteristics. We have looked upon them as though they were tiny, solid balls. But such is not the case. Each atom is indeed a complicated system of units and we are by no means sure as yet just what all of these units are.

Before we can consider alloy formation in any scientific manner, we must understand more about the atom itself. In so far as we know, each atom is composed of a very small but very heavy inner portion called the nucleus. In fact, the nucleus makes up far less than 1 percent of the total volume of the atom, yet it contains practically all the weight of the atom. Could we but bring together the nucleii of even our lightest atoms, we would have a material so heavy that no man could lift a match box full of it from the earth.

Out beyond the nucleus—far out in space, as atoms go—lie the almost weightless electrons, like satellites or outposts guarding the nucleus. The atom of each species of metal has its own particular number of electrons arranged in guarding layers around the nucleus. Some light metals, like aluminum, may have less than ten of these flanking patrols, while others, like lead, may have upward of 70. But in all cases they are arranged in layers such that the outermost layer or shell contains less than eight and generally less than five of these electrons. These are the tiny units which tie atoms together, the fewer the electrons per atom the less rigid the tie and, conversely, the larger the number the more rigid the tie. [This will be discussed more completely in an article by the author, to be published later.—*Ed.*] Thus, the force holding metal atoms together resides in the electrons, and the softness and ductility of a metal depend in a large part upon the number of electrons present. Where there are few electrons, the atoms, though held together by considerable force, can, nevertheless, slide past one another and the metal is soft and ductile. Such is the case with silver, copper, and gold, where each atom has but one of these outermost electrons. On the other hand, bismuth, with five electrons per atom, is hard and brittle, crumbling at the blow of a hammer.

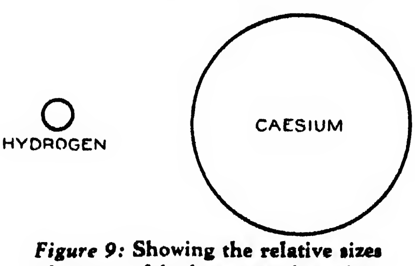


Figure 9: **Showing the relative sizes of atoms of hydrogen and caesium**

The last factor which we may consider before applying these factors to the science of alloy formation is the size of the atom. Atoms are, in general, so small that we seldom think in terms of size difference. Yet in this world of the invisible there is more difference in size between that of the smallest atom (hydrogen) and that of the largest atom (caesium) than between pygmy and giant (Figure 9). The volume of the copper atom is some 60 times that of the hydrogen atom. The size of the atom also plays an important part in the nature of the metal and in alloy formation. As might be almost predicted, metals having the largest atoms are the softest and most ductile metals, while those with smaller atoms are harder and more brittle.

IT becomes evident that the softest, most ductile, and most malleable of all the metals will be those having both the largest atoms and the fewest flanking electrons. To this group belong, in addition to copper, silver, and gold, the little-known metals, sodium and potassium. These metals are so soft that they cut like cool butter to exhibit a brilliant metallic surface which tarnishes rapidly in the air. Because of their bad rusting habits, these metals play no part in commercial alloy building and are, in fact, largely laboratory curiosities. At the other extreme with small atoms and a larger number of flanking electrons come the hard, brittle metals, boron and beryllium. Though still a rare metal, beryllium has begun to find important uses in alloy building because of its extreme lightness. It is the lightest of the usable metals, being but two-thirds of the weight of aluminum.

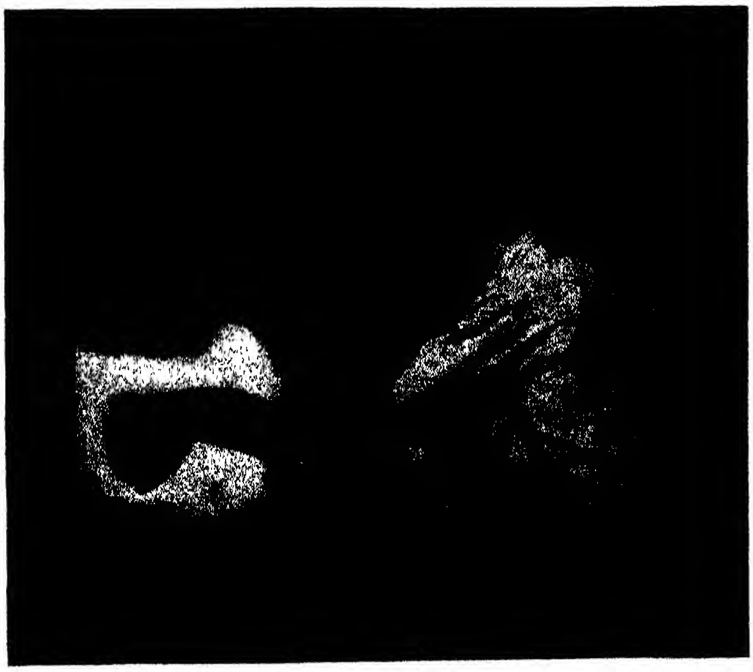
We have now considered the three important factors in the science of alloy formation. They are (1) the type of crystal lattice, (2) the number of electrons in the outer layer or shell and, (3) the size of the atom.

In Part II we shall show how these factors are applied to the formation of alloys to determine in a considerable measure the type of alloy to be expected.

(To be concluded)

OIL HEAT SAVES FRUIT

WHEN Mother Nature slips a cog, and sends cold weather where warm weather ought to be, fruit growers must supply artificial heat to protect their valuable groves. Old type smudge pots, long used in Florida and California, are being replaced in some sections by oil-burning heaters from which warm air is blown over large areas by a huge engine-driven propeller. *Andrew R. Boone.*



Oil burner at base of wind tower. Crude-oil flames impinge on a heat chamber, heat rises up the stack and is blown out over the fruit grove

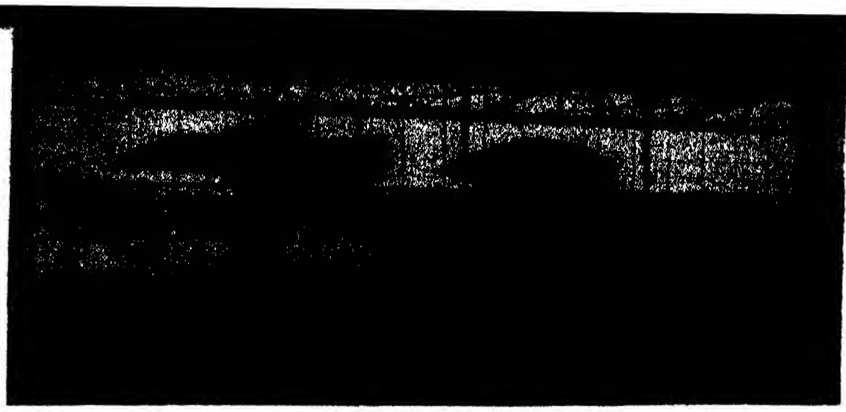
One of the new heating machines in a fruit grove at La Habra, California. The machine stands over 30 feet high, can be used to circulate hot air or to mix upper and lower strata, equalizing temperatures. Being smokeless, these machines have advantages over old smudge pots

Although in actual use the heating machines give forth no smoke, smoke was added to the warm air to illustrate in photographs how the machine distributes heat over a wide area. An automobile engine drives a six-bladed propeller and rotates the tower top. It is claimed that one of these machines can protect 10 acres of trees against frost

A Clipper Ship is Built

Photograph by Ivan Dmitri

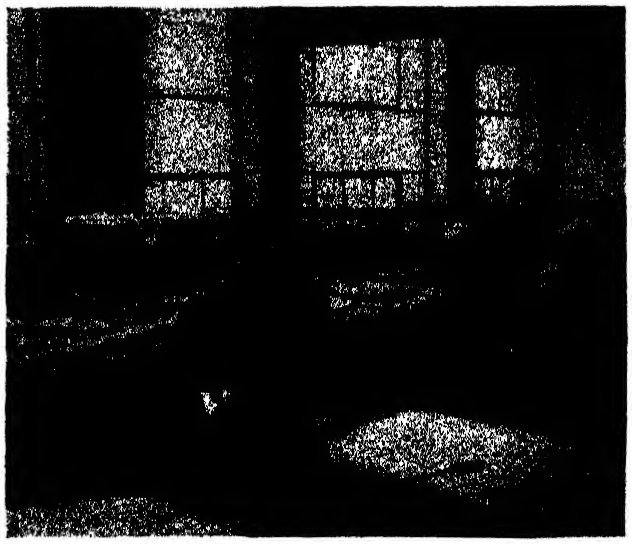
1 The name of Igor Sikorsky is definitely linked with huge, multi-engine flying boats. Since the construction, in 1913, of the first multi-motored airplane in the world, Mr. Sikorsky has forged steadily ahead in the design of larger and more powerful ships. He is pictured here with an exact scale model of a flying boat, the first concrete step to be taken by engineers in the production of a new type



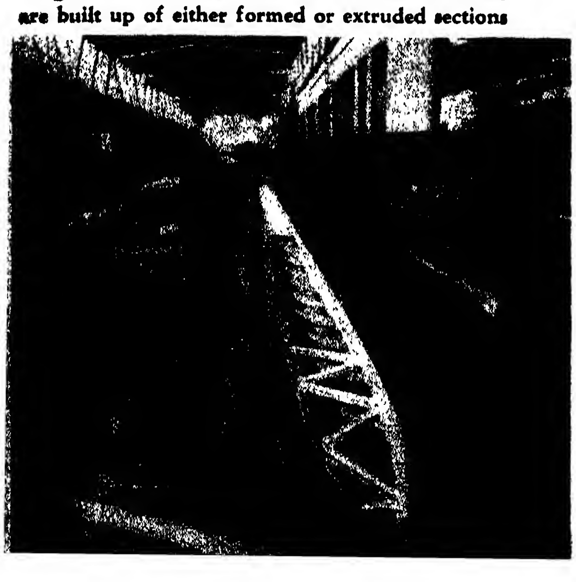
2 "Round-table" discussions, preliminary sketches, estimates of performance, strength, and weight, precede the construction of the scale model shown at the left. Then follow the experimental engineering stages, during which the scale model is made, wind-tunnel tests are conducted, hull models are towed through water, and a full-size "dummy," known as a mock-up and shown above, is constructed of wood and fabric. This mock-up, no small construction job in itself, enables the designers to determine the best locations for controls, seats, and other details both exterior and interior

3 *Left:* Delicate instruments make possible accurate tests in the vertical wind tunnel, one of the few of its type in the world. From these tests come accurate predictions of performance and aerodynamic characteristics, as well as important contributions to basic design of aircraft

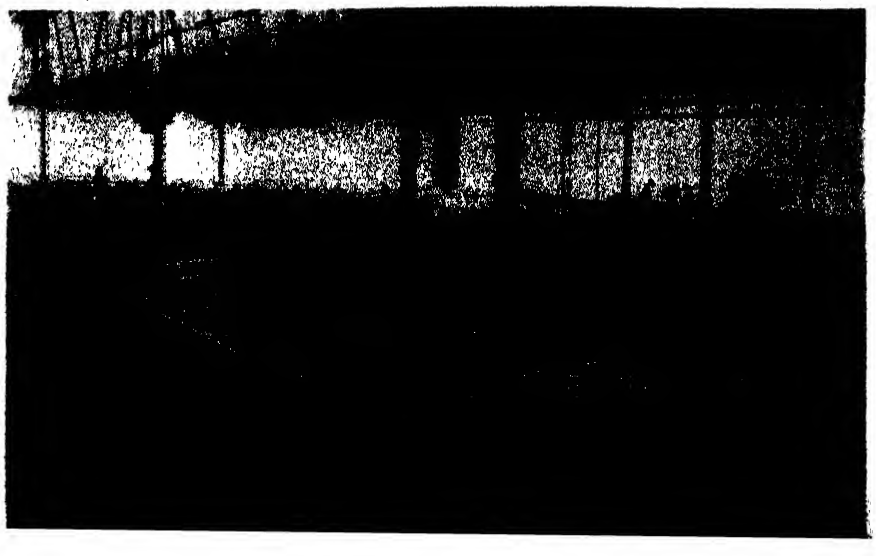
4 *Right:* A corner of the drafting room. In a plane like the Sikorsky S-42 there are nearly a million and a half detail parts. Two thousand complete working drawings are made



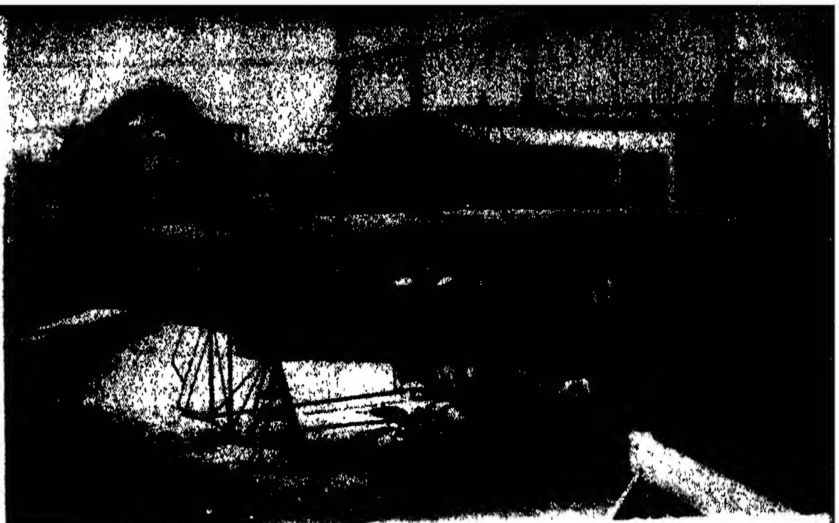
5 *Below:* After mechanical specifications have been decided, fabrication begins. Spars of aluminum alloys are assembled in jigs, as shown, for wings and tail surfaces. The structural members are built up of either formed or extruded sections



6 *Below:* Assembling the wing center section, where also aluminum alloys are used throughout. Work on the various structural units of a Clipper ship goes forward simultaneously in different departments, all geared to bring the units together for final assembly and to insure accurate fitting and interchangeability of a multitude of parts



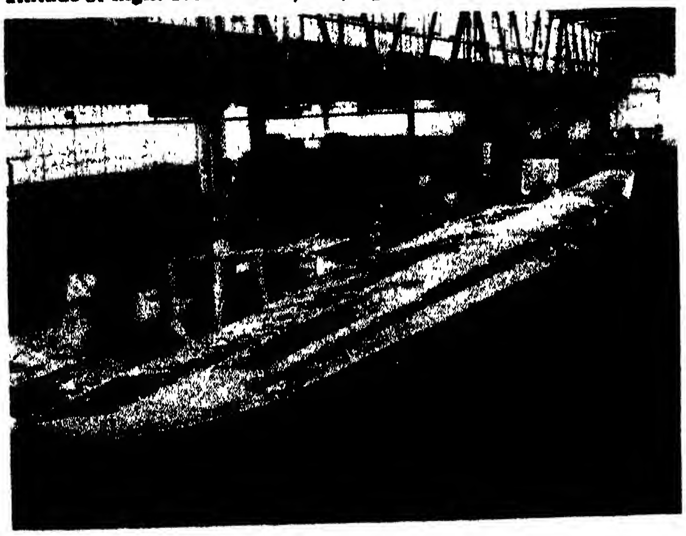
7 In a huge jig the hull takes form. Materials purchased for use in these huge ships of the airlines are subjected to rigid inspection for size and physical or chemical properties before they are released for shop use. This policy of meticulous inspection, supplemented by strength tests of structural parts, is followed throughout the construction; nothing is left to chance

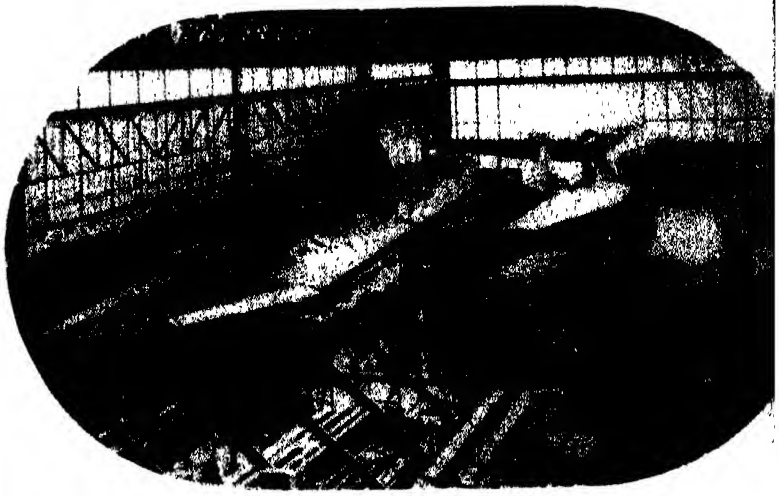


8 Out of the jig comes the hull, a metal shell into which must be fitted the luxurious interior of a modern airliner. Sound-proofing materials must be installed, the seats put in place, the galley equipped, and provision made for the controls and instruments in the pilots' compartment. The exterior of the hull is covered with a sheet metal skin which is riveted over the metal bulk-heads shown at the left. More than 5000 square feet of sheet metal are used for the entire plane

By A. P. PECK

9 *Below:* The three sections of the wing are brought together and assembled, prior to installation above the hull. One of the most important parts of the finished plane, the wing does the greatest amount of work. It is built with extreme care and accuracy, and is stressed far in excess of any loads that may be imposed on it in any attitude of flight occasioned by varying flying and weather conditions





10 The final assembly floor, with three huge Sikorsky flying boats nearing completion. Here for the first time the wing and fuselage meet, completely covered with their metal skins and ready for the installation of power plants, accessories, the intricate "nerve-system" of control cables, electric wiring, and instruments. Over half a million rivets are used in the assembly

11 *Below:* Engines installed, cowling in place, propellers attached—an assembly job is finished but the most important work of all is still to be done. After the power plants have been tested for proper functioning, the ship takes to the air for a long series of test flights—the final proof of the design

12 *Below:* Thousands of hours of discussion, planning, testing, construction, bear fruit as the huge Sikorsky proves up under flight conditions, verifying the performance characteristics that had been pre-determined by the engineers in their search for the ultimate in mechanical perfection

PULSATING STARS

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington.

THERE are thousands of stars in the sky that vary in brightness, and more are being discovered every month—usually by comparison of photographs of the sky taken on different dates, and often as a by-product of quite other lines of investigation such as the search for proper-motion stars. When the discoverer has identified his star, by publishing a chart on which it is marked, or otherwise, and the variation is confirmed by adequate evidence, it receives a letter or number in the great list of variable stars which is kept up by international agreement by the German Astronomische Gesellschaft. Then the work of astronomers has only begun. It is not very important merely to know that the star changes in brightness—we must find out how it changes. Some stars lose and regain part of their light, at regular intervals, in a way which can be accounted for by eclipses by companions revolving close to them. We have a very satisfactory theory to explain the variations of these stars; but it starts by assuming that the separate stars of the pair do not really change in brightness at all! They only hide one another from us.

MOST variable stars change in a way that cannot possibly be explained by eclipses—they must be *really* variable. This happens in many ways, but it is noteworthy that there is hardly a single star whose behavior is unique—in practically every case others have been found which vary in a similar fashion. For some, the changes are quite irregular, for others, there are great outbursts of light, gradually fading away; but there are a great many which repeat their variations time and time again, some of them approximately, and others precisely. Stars which do the same thing regularly, at equal intervals, are obviously the most promising for intensive study, in the hope of finding out what really happens to them. The most noteworthy objects of this sort are the Cepheid variables—so called from the bright star Delta Cephei, which is a typical example. These vary continuously in brightness in periods exactly fixed for each star, but ranging from 1½ to more than 50 days from one to another. (A very similar group, with periods less than a day, need not be mentioned here.) The range in brightness is moderate, very rarely more than four- or five-fold, for visual observations. Photographically it is somewhat greater, for the stars are always whiter when they are bright, and redder when they are faint. At the same time the spectrum changes, being "earlier" at maximum light than at minimum—that is, nearer the head of the Harvard list of classes, B, A, F, G, K, M.

This set of simultaneous changes makes us practically certain that the immediate cause of the variation is a change in the temperature of the star's surface. A hotter star should be brighter, whiter, and have an earlier spectral type. The changes in all three agree pretty well with those which would result from a change of 15 or 20 percent in the temperature—and no one doubts that such changes actually occur.

But why should the temperature of a star change, over billions of square miles of surface, by almost a thousand degrees? and then come back where it was at first, and do it again and again? and take the same time about it on every repetition? The regularity in time gives us a clue. There are two types of oscillation which we use, in every-day life, as time-keepers—motion of a body under gravitational force, like the pendulum of a clock, and motion under elastic forces, like the balance-wheel of a watch or a tuning-fork. Both forces are operative in a star—gravitation pulling it together, and the elastic force of gas-pressure keeping it from collapsing. An ordinary star is in equilibrium. But suppose we could take such a star and suddenly compress it in every part, so that it was reduced to 90 percent of its original diameter. Gravitation would be stronger, since all parts of the star are nearer together, but a simple calculation shows that the gas-pressure would be still more increased. So, if the star, after being held at the smaller diameter, were let go, it would expand to its original size. When it got there, all parts of it would be moving outward (the surface fastest) and it would overshoot the mark—like a pendulum drawn to one side and let go—and keep on expanding till it got as much too big as it had been too small. In this condition the gas-pressure would be too weak to balance gravitation—the star would contract again, and return to the state from which it had started, just as a pendulum swings back to the point of its release. Successive oscillations would take just the same time—again like a pendulum. Such a change in size of a star is called pulsation. Once started, it would keep on for a very long time; for, though there are influences which act like friction to slow the motion, these are very small.

When the star was smallest, the gases in the interior would be compressed and hotter than the average and, when it was largest, they would be expanded and cooler. This pulsation theory—suggested by Shapley and developed mathematically by Eddington—is now generally accepted as the explanation of Cepheid variation.

THE changes are on an enormous scale, for these stars are very bright. They have been observed in distant star-clusters and clouds—notably the Magellanic Clouds—and even in the nearer spiral nebulae, and in every one of these systems it is found that the average brightness is nearly proportional to the period of variation. Knowing this, we may utilize observations of the stars in our own system, which are near enough to be visible with the naked eye, to get the actual brightness corresponding to a given period. Though these stars are near the outer limit for direct measures of distance, the evidence is strong that, for a period of ten days, the brightness averages about 1000 times that of the sun, ranging in a typical case from 600 to 1400 times the sun's light. For a period of three days the average light is some 350 times the sun's, for 40 days about 3000. The luminosity does not increase quite in proportion to the period.

The *changes* in brightness of even the least of these stars exceed the total light-emission of a hundred stars like the sun.

In size, as well as in brightness, these stars are giants. Those with periods of three or four days have on the average spectra nearly like the sun's and probably give out about the same amount of light per square mile—which would make the diameter of such a star 20 times the sun's, or about 17,000,000 miles. The stars of longer period are cooler, and must have larger surface areas in proportion to their light, so that one of ten days' period is about 40,000,000 miles in diameter, and the diameter for a period of 40 days probably exceeds 100,000,000 and perhaps 150,000,000

When Stars Pulsate in Brightness, What Really Happens and Why? Such Changes Take Place on an Enormous Scale . . . A Star's Diameter May Rise and Fall by as Much as 40,000,000 Miles and at a Rate of 25 Miles a Second . . . New Data Increase Our Knowledge but We Still Have Much to Learn

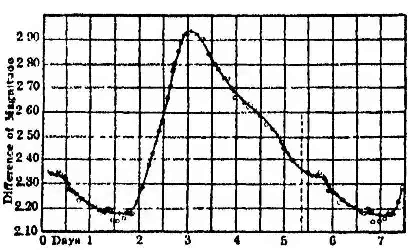
miles—comparable with the earth's orbit.

If stars as huge as this expanded and contracted by any considerable percentage, the motions of their surfaces would be fast enough to be detected by the spectroscope—and, in fact, every Cepheid variable which has been adequately observed shows changes in radial velocity. The rate of motion is moderate— as such things go--averaging about 20 kilometers per second on each side of the mean (which represents the steady motion of the star's center toward or from us).

But even this "small" value (compared with other astronomical figures) means that the diameter of an average variable —which is affected doubly by the motion of both surfaces -is at times increasing or decreasing at the rate of 25 miles every second, or more than 2,000,000 miles per day. For the stars of shorter period the motion slows up after a day or so, and the whole change in diameter, for the majority of the variables, does not exceed 3,000,000 miles. But the stars of longest period—for which the rate of motion is found to be greater than the average, alter much more. The extreme range in diameter so far detected amounts to 40,000,000 miles. This sounds —and is—extraordinary; but we must remember that such a star, with a period longer than 40 days, may be 150,000,000 miles in diameter, so that the change, on each side of the mean diameter, would only be 13 percent. The percentage change in size of the smaller stars of shorter period appears to be smaller, and usually less than 10 percent each way. All this is strongly in favor of the pulsation theory—while spectroscopically calculated motions larger than the diameter of the stars would have killed it. Moreover, the percentage changes in diameter and in surface temperature are of about the same size—which makes sense. The changes in size combine with those in temperature and surface brightness to produce the observed variation; but the temperature changes have considerably the greater effect.

UNTIL recently, spectroscopic data of this sort were available for only 29 of the brighter Cepheids. The list has been greatly increased by a long and successful campaign of work by Dr. A. H. Joy, of Mount Wilson, who has just published the velocities of 126 additional stars of this class, including practically all which are accessible to a telescope in the latitude of California. All but two of the variables previously studied are brighter than the eighth magnitude; all but three of Joy's list are fainter than this limit, and some are of the thirteenth, or even the fourteenth magnitude.

This remarkable extension of our knowledge is due not only to the great reflectors but to special spectrographs, giving short spectra which could be photographed in three hours, even for the faintest stars. As the spectra of stars of this sort are rich in strong lines, good



Light curve of Delta Cephei, the typical star and prototype from which the term "Cepheid variable" is taken. The curve is by Joel Stebbins and is reproduced from Russell, Dugan and Stewart's "Astronomy", courtesy of Ginn and Co.

determinations of the velocity could be secured; but, as the velocity varies, at least five, and usually eight or ten observations were made for each star, so that almost 1000 spectra had to be secured ---an enormous piece of work.

Every one of the newly observed stars shows regular variations in velocity, of the same type as for the brighter variables, and, for every one, the range is small enough to indicate a pulsation of only a moderate fraction of the star's probable radius. The confirmation of theory is in this particular all that could be desired.

But there is one point where the pulsation theory, attractive as it is, gets apparently into trouble. The stars are brightest, not when they are smallest (and must be hottest inside), but when their surfaces are approaching us most rapidly—that is, when the stars are expanding fastest; and they are faintest when they are most rapidly contracting. This rule, established by the observations of the first few bright stars, is confirmed completely by Joy's extensive work. There is no flagrant exception among all the stars. The time of greatest brightness usually comes a little ahead of the time of most rapid expansion, and the same is true for minimum brightness and contraction, but when allowance is made for this, the deviations for individual stars are not serious.

Another property, shown by the light-curves, is confirmed by the velocities. The rise from minimum to maximum light is usually faster than the fall to minimum again, and for many stars takes less than half as long—though, for a few, the rise and fall are equally rapid. It is found, correspondingly, that the time between the most rapid contraction and fastest expansion—roughly speaking, the interval when the star is smaller than its average size—is less than half the period, while the star is larger than the average for more than half the time.

This last fact is not hard to understand on the pulsation theory. When the star is smaller than normal, all the forces acting on it, and, in particular, the internal gas-pressure, are increased by a larger percentage than the percentage of decrease in the forces when the diameter is increased by the same amount. Hence the oscillations are not like the swings of a pendulum, which is subject to just the same restoring forces at the same distance on the right and left, and so takes exactly the same time for one half of its swing as for the other.

The more powerful forces operating when the star is small produce a quicker effect. (This is a very good example of an explanation which, while sound as far as it goes, omits a great deal of the complications of the real problem. Eddington's careful mathematical discussion of the problem is not easy reading for anybody.)

BUT the lag of maximum brightness, and maximum surface temperature, behind the time of maximum central temperature, is not so easy to explain. In a rough and general way we may assume that it takes some time for the effect of the internal heating to work its way out from the interior to the surface; and it does seem safe to say that a lag in the surface temperature is much more intelligible than a "lead"—as an electrical engineer would call it. But the details have not yet been successfully worked out. There is no reason at all to believe such a solution impossible, and from what one picks up in talking in astrophysical circles, there is good hope that the resolution of the difficulty may not be far off. There is therefore no sufficient reason to discredit the pulsation theory, which accounts for so much, because this complication has not yet been cleared up. —*Princeton University Observatory*, December 4, 1937.

HARMONIOUS HORMONES

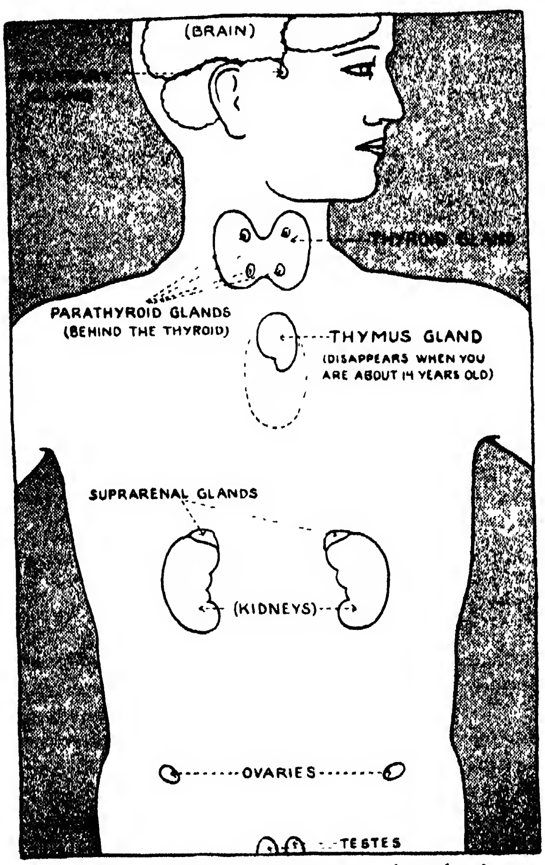
Medicine's Newest, Shrewdest Weapon . . . Mystery of the Endocrines . . . Thanks to Recent Discoveries . . . The Promising Whale Proved to be a Disappointment

By MORRIS FISHBEIN, M.D.
Editor of *The Journal of the American Medical Association*, and of *Hygeia*

HAVE you ever seen a case of "cretinism?" Here is a heartbreaker – a four year old child, dwarfed physically and stunted mentally because he was born with a defective thyroid gland. His blubber lips, thick protruding tongue, and sunken nose give him a bestial aspect; he is, as the great Osler said, "the pariah of nature." But thanks to recent discoveries in endocrinology he can be rescued from drooling idiocy and lifted to a normal plane of life if thyroid treatment is begun at once.

The mystery of the endocrines is not yet wholly bared, but there is already much that can be definitely stated concerning these tiny organs that pour their secretions directly into the blood stream. We know that our physical growth, mental energy and general attitude toward life depend largely upon the concerted activity of a few glands which altogether do not weigh more than three quarters of a pound!

The endocrines manufacture powerful chemical substances called *hormones* which have the power of arousing certain bodily functions and inhibiting others. Thus, when we are confronted by physical danger, our adrenals pour out floods of adrenalin, a hormone which sends towering energy to the muscles of flight and battle. With the onset of winter our thyroid grows slightly larger in preparation for the increased demands that cold weather will make upon us. When soil and water are deficient in iodine, the thyroid visibly enlarges in an attempt to compensate for this lack, and "goiter" results. In the Great Lakes region of the United States a high percentage of female school children were formerly goitrous, but by administering small quantities of potassium iodide twice a year, Marine demonstrated that the disease could be reduced to less than 1 percent. In some American cities the municipal authorities now supply chocolate-coated tablets containing one tenth grain of potassium iodide once a week for 20 weeks. Table salt, slightly iodized, is also a cheap and excellent preventive.



A summary chart of the several endocrine glands of the body. These work in unison

If the thyroid becomes *too* active, a forced draft fans our energy fires. Observe a woman, suffering from a too-busy thyroid; her hands tremble, her eyes pop, her whole body vibrates with purposeless agitation; ultimately she will collapse unless her thyroid activity is halted. Surgical intervention is necessary here; a delicate operation will remove a portion of her thyroid, leaving just enough to maintain the thyroxin level essential to normal life.

The pituitary gland, located as shown in the drawing, is the motor of our sex and also produces the hormone controlling growth. Tadpoles and rats stimulated artificially by this hormone grow to enormous proportions. In normal human beings, however, the growth hormone begins to subside at puberty, and the pituitary then releases its gonad-stimulating hormone. Under its influence, the cells of reproduction begin to ripen, and characteristic sex changes take place. But observe what happens when the pituitary is laggard at this point: here is a fattish adolescent boy with the bodily configuration and voice of a girl. Excessive fat is distributed in heavy folds around his girdle, his breasts are prominent, while his genitals have remained infantile in size. His schoolmates laugh at this sorry creature, and unless his condition can be improved, serious behavior complications will ensue. But when he receives injections made from the fresh pituitary glands of cattle, his fat rolls off, his voice deepens, his genitals attain normal size and function. The injections have stimulated his lagging pituitary and thus supplied him with the hormones essential to his proper development.

THE thyroid loads our nervous system with energy, the adrenals fire it. The adrenals are two in number, riding the upper pole of the kidneys like a triangular cocked hat. Tuberculosis of the outer covering of these glands leads to once-fatal Addison's disease, a malady that can now be controlled by use of cortin —a hormone extracted from the adrenals of cattle. Just as cretins are treated with thyroid extract, sufferers from Addison's disease are supported by injections of cortin, one of the most potent extracts in the modern medicine chest.

Adrenalin, the dramatic stimulator of the heart and nervous system, is now commercially produced by treating the inner portion of the adrenal glands of animals. This powerful extract also has the special property of relaxing the smooth muscle of the bronchial tract, and is therefore of specific value in the treatment of asthma. In women, tumors of the adrenal cortex lead to profound changes in appearance; the bearded lady in the circus is frequently suffer-

ing from an adrenal tumor. Her beard might disappear if the tumor were dissipated by X rays or surgically removed.

A French physiologist once remarked that a woman is but an appendage to her ovaries. This may sound excessively gallic to our sensitive American ear, but the fact is that the entire feminine organism is sadly deranged when normal quantities of the female sex hormones are not secreted. These hormones are now commercially available in standardized units. To relieve many female ailments, including barrenness due to endocrine causes, physicians now prescribe these standardized hormones, and medical opinion agrees that such treatment is strikingly effective.

Nested behind the thyroid are four tiny nodules about the size of a grape seed. These, the parathyroids, provide an efficient mechanism for the mobilization of calcium. Without calcium the body would be in a state of muscular agitation known as tetany, a truly serious disease in which the sufferer is thrown into agonized convulsions by the slightest stimuli. The parathyroids prevent these excessively violent neuromuscular reactions, by keeping calcium at a certain level in the blood; if the parathyroids are damaged or removed, the proper calcium level can be maintained by the injection of the parathyroid hormone, parathormone, combined with a diet rich in calcium and vitamin D.

INSULIN is secreted by the islands of Langerhans, small cells occurring in the pancreas. If these "islands" lose function, sugar and starch cannot be used by the body, and diabetes results. Until the hormone insulin was isolated from animal pancreas in 1922, diabetic patients were doomed to coma or starvation. Today, commercially prepared insulin obtained from animal pancreas enables 300,000 diabetics in the United States to lead lives closely approaching normal.

Few people appreciate the sacrificial rôle played by animals in providing the raw material from which commercial hormones are made. The great meatpackers operate huge laboratories devoted solely to the manufacture of gland extracts obtained from meat animals. The glands are ground and desiccated; secret chemical methods are employed to extract the precious essence in liquid and crystal form. To make a single ounce of insulin powder, 1000 pounds of animal pancreas must be treated. Naturally, the cost of these animal hormones is high. A European pharmaceutical house, rebelling at the price of American cattle glands, attempted to extract hormones from whales, but they found that although the whale has a 750-pound liver and a 100-pound kidney, his pituitary gland weighs just half an ounce!

Photo Ewing Galloway

A matter of endocrine gland behavior—or rather, of misbehavior. Jack Earle, eight feet seven inches in height, and Major Mite, standing one foot eleven. In cases of these types the pituitary or growth-controlling gland is involved

The endocrine glands have been compared with an interlocking directorate ruling the affairs of the body. But on this glandular board, unanimity must prevail; if a single dissenting voice is heard, confusion is inevitable. Let the pituitary increase its function by 1 percent, and the other glands violently record the change, registering it in turn on all the organs and tissues of the body. From the therapeutic point of view these interactions create serious problems; one cannot, for instance, stimulate the pituitary without affecting other bodily functions. A few years ago it was suggested that a fraction of the pituitary had the power of growing hair on bald heads. The early rejoicing subsided when it was found that this same fraction might stimulate or disturb sexual functions, and disorder the normal growth of bones—conditions worse than baldness.

Steadily, the fruits of endocrine research come in from laboratories and clinics; some are discouraging, some are puzzling and contradictory. The literature grows labyrinthine; no single mind can encompass the scope and influence of the ductless glands. But, out of the countless researches, a definite unity emerges as the science of endocrinology forges medicine's newest, shrewdest weapon in the unremitting battle against human suffering and disease.

PROTECTION FOR THE PUBLIC

Do We Need New Food, Drug, and Cosmetic Laws? The Accompanying Article, Written at Our Request, Answers This Vital Question

By SENATOR ROYAL S. COPELAND

IT is a ghastly thing that drug legislation waits on a tragedy like the 73 deaths from sulfanilamide elixir. Why is it that legislative bodies deal only with emergencies, rarely in advance of disaster?

For five years I have struggled along, and almost alone, in attempts at congressional action. The appeals of the responsible departments of the Government have been without effective results. Twice the Senate has acted, once the House acted, but for almost a year final action on the latest bill has been deferred in the House of Representatives.

I am not blaming any individual or committee. What is happening is characteristic of congressional inertia. The consumer group is usually voiceless; no public pressure is exerted to pass this bill, the sort of pressure that is extremely active when selfish interests are at stake. This particular measure, the pending Food, Drug, and Cosmetic Bill, is of interest to the public only in the sense that smallpox and typhoid fever are of interest; during their appearance in epidemic form, every citizen demands action by the authorities. Perhaps the unfortunate deaths from sulfanilamide elixir will arouse the public and the Congress. If this should be the case and out of this disaster comes the enactment of a worth-while law, the victims of this needless poisoning will not have died in vain.

Suppose we review the reasons why the Food and Drugs Act of 1906 should be revised. The revision is designed to furnish a more effective weapon than Dr. Wiley's now antiquated statute provides. Modern commercial practices, which Dr. Wiley and his associates did not and could not anticipate, call for new methods of control. Defects in the law itself, as revealed by hundreds of court decisions, must be remedied if consumers are to have adequate protection.

When the original law was drafted, manufacturers depended to a great extent upon the labels of their products to sell the goods. Truthful labels seemed quite enough to protect the consumers; no provision was made for bringing other forms of advertising under control.

Today, most manufacturers keep their labels above reproach. The truth is found there. Unfortunately, however, there is a relatively small group that does not hesitate to make preposterous claims in printed and radio advertising. Such unscrupulous persons know that they run no risk of penalty under the existing Food and Drugs Law.

Other problems in connection with foods and drugs have arisen through changed modes of living. Where most foods were once made ready for the table in the housewife's own kitchen, today more and more foods are prepared outside the home. Thanks to modern scientific methods of processing, many of them are cheaper and even better than the housewife could produce. But in the production of others, I regret to say, there are grave abuses which cannot be controlled under laws that with a few exceptions make no provision for legal standards or for adequate sanitary supervision.

Cosmetics, comparatively unimportant in Dr. Wiley's time, are now produced in such vast quantity as to make the business a major industry. It is one which is related to the health and pocketbooks of millions of consumers. Yet, unless their labels carry medicinal claims for diseased conditions, even poisonous cosmetics do not come within the law.

LIKEWISE, many dangerously potent drugs enjoy an unrestricted sale under labels which give no hint of their harmful character. Because they are not adulterated and their labels, so far as they go, are not untruthful, they are freely sold. Except for a few specifically named narcotics and habit-forming drugs, precautionary labels cannot be required under present laws.

Twelve women in California, in the San Francisco region, naturally anxious to improve their looks, were stricken blind after using a certain fat-reducing preparation. It was a product containing a very dangerous drug, dinitrophenol.

In our hearings before the Senate Committee there were exhibited some horrifying pictures. They were of a person, a handsome young woman, who had gone to a beauty parlor to have her eyelashes dyed. The eyes were burned out and the face terribly disfigured, the effects of a drug to which she happened to be susceptible.

We spend in one year around two or three hundred million dollars for cosmetics. It is indeed a tremendous industry; and fortunately, you will be glad to learn, most cosmetics are harmless. But there have been instances of serious injury, and some deaths, following the use of cosmetics. A cream sold under a trade name was claimed by its promoters to be not only a superior and harmless depilatory—a hair remover—but also of actual benefit to the skin. As a matter of fact, it contained a potent ingredient more appropriately used as a rat poison—thallium acetate. Many who used this product became bald. Others suffered severe muscular pains, nerve impairment, and paralysis.

Among the efforts of the Government to suppress the sale of products for which fraudulent and untruthful claims were made, was that of an attack upon a product containing ammonia, turpentine, water, and egg. It was first sold as a horse liniment, but the enterprising owner found more money in offering it as a remedy for human tuberculosis, pneumonia, and a long list of other serious diseases. Back in 1922 a case was brought against the manufacturer, alleging, in the language of the present law, that its preposterous therapeutic claims were "false and fraudulent." Under this wording of the statute it is necessary for the Government to prove, not only that the label statements were false, but that the manufacturer knew them to be false. Physicians skilled in the treatment of tuberculosis testified that the labeling was false. But the manufacturer, a man of advanced years and the dignity of a patriarch, gave such convincing testimony of his faith in the product that the jury decided in his favor.

Through the ten years that followed, before the Court finally curbed this audacious fraud, Government investigators followed up a long list of its victims. They had been persuaded by the label to treat themselves for tuberculosis and other diseases with this miserable stuff and subsequently died from those diseases. Among the victims were three sisters, Martha, Elizabeth, and Marga-

ret, who were admitted to a well-known tuberculosis sanatorium in 1924. Margaret heard of the product I am discussing. She was not allowed to use the nostrum in the sanatorium, so she left so that she might use it at home. She induced her sisters to leave for the same home treatment. Martha died after using the fake remedy for about four months. Elizabeth used it for about the same length of time and then returned to the sanatorium, only to die three months later. Margaret, whose tuberculosis was only moderately advanced when she went home, depended on the product for an entire year before she returned to the sanatorium, her disease far advanced. It was not long before she died.

But evidence of this kind was not enough to establish a legal case under the Food and Drugs Act. The evidence had to show that the manufacturer *knew* that his product would not confer the benefits he claimed for it.

The mass of other cases investigated included that of a tuberculosis victim in New Hampshire who wrote testimonials for this fraudulent compound, claiming she was cured. The woman was paid for this service, and while she was on her deathbed her son wrote testimonials signed with her name. Her death certificate showed the cause to be tuberculosis.

MORE than 60 certificates were found showing the deaths of users of this extract from maladies which the labeling promised to cure.

For several years the gross sales of this useless thing amounted to more than 100,000 dollars annually. In one year the sales reached a peak of 367,000 dollars. This gives some idea of the number of persons who were using the fake remedy.

Space does not permit the recital of many other instances of failure to deal effectively with similar evasions of the spirit of the law. But surely enough has been said to show what the Government faces under the present Act in its efforts to protect the public against hundreds of dangerous and worthless nostrums. The maker of a fake "cure" who is unaware of the loopholes in the Food and Drugs Law may be promptly caught and brought to book. But another maker of the same nostrum, with the same labeling, who knows how to cover up evidence of his bad faith, may continue in business indefinitely. But the victims of the one fake are just as dead as the victims of the other.

When Eben M. Byers, wealthy Pittsburgh manufacturer and former amateur golf champion, lost his health, he was persuaded to dose himself with "certified radium water." Perhaps he reasoned that if it didn't cure him it wouldn't do any harm. But the medicine killed him; it literally disintegrated the bones of his head in but a short time.

Newspaper editorials were caustic in their criticism of the Government. Why wasn't the Food and Drugs Act enforced? Editors, in common with most well-informed persons, assumed that the Food and Drugs Law prohibits nostrums that are dangerous to health when used according to directions on the bottle or in advertising. Unfortunately, the law does *not* prohibit or restrict the sale of dangerous drugs. Only when the labels of medicines bear "false and fraudulent" therapeutic claims or misrepresent the identity of the ingredients are the manufacturers subject to legal action. The label of the medicine that killed Mr. Byers bore only a simple, truthful statement that the product was a radium-active water. It was sold within the law.

Preparations used for rheumatism, neuritis, and similar disorders may contain cinchophen, a drug that injures the liver. Among many reports in recent medical literature of the deadly effect of this substance is one from the Mayo Clinic, describing five fatalities. In October, 1932, *The Annals of Internal Medicine* reported six deaths from cinchophen poisoning, four of them caused by one proprietary medicine. Such reports multiply as time passes. The present Food and Drugs Law does not require that cinchophen be declared on the labels of preparations containing it.

For many foods the Department of Agriculture has adopted administrative standards based on good household and commercial practices. Such standards are merely advisory, not having the force and effect of law. But if manufacturers can be persuaded to follow such standards or if there is a widely recognized household practice, there is set up a kind of "common law" understanding as to the nature of the product in question and legal actions are taken on that basis. But not always successfully!

Far-sighted manufacturers in most food industries gladly accept such voluntary standards. But, of course, without legal standards the integrity of our foods cannot be assured; neither consumers nor honest manufacturers can be protected against the unscrupulous practices of those who profit by debasing the things we eat.

Many more examples could be given to show the inadequacy of the present Food and Drugs Act, but let us now consider S. 5, the Food, Drug, and Cosmetic Bill that passed the Senate. The bill was written after many and extensive conferences with the enforcement agencies of the Government and with representatives of various consumer groups and associations, professional groups, and the industries to be regulated. Letters inviting suggestions were sent to many persons known to be interested in the proposed legislation. Several volumes of suggestions were received from persons in the groups mentioned, and these were carefully studied. Many of the suggestions were rejected, some were accepted, and others accepted in part or in effect. The hearings held by committees of the Senate and House of Representatives on previous bills in former sessions of the Congress were reviewed and studied. While it is not perfect, of course, the Senate bill lays the foundation for a very complete act after the House has made its changes and improvements.

THE one factor, more than any other, which has withheld action on the revision of the Food and Drugs Act has been the controversy as to whether the Food and Drug Administration or the Federal Trade Commission should enforce the provisions relating to advertising. On the premise that advertisements of foods, drugs, and cosmetics are nothing more than extensions of the labeling, it seems to me that the control should be vested in the Food and Drug Administration which enforces the provisions having to do with adulterations and labeling.

This would not have the effect of depriving the Federal Trade Commission of its jurisdiction to proceed against false advertising in such form as to make it an unfair method of competition. Bill S. 5 specifically provides that it shall not be construed as impairing or diminishing the powers of the Federal Trade Commission.

I fully agree with what Secretary Wallace of the Department of Agriculture said:

"Division of the law to give control of adulterations and misbranding of foods, drugs, cosmetics, and devices to one agency and false advertising of the same products to another will inevitably result in needless expense and inefficiency. Responsibility for control of adulterations, misbranding, and false advertising should be lodged in one administrative agency."

It will be a pity if we let this Congress die without passing effective legislation in the field of foods, drugs, and cosmetics. The health and lives of all our people are directly related to this matter. We want no more "Ginger Jake" tragedies, no more sulfanilamide disasters. We want no more victims of diabetes, Bright's disease, tuberculosis, cancer, and other serious ailments to be enticed to death by the false and fraudulent claims of unscrupulous and ruthless advertisers. We must make an end of worthless foods and those cosmetics that carry dangerous ingredients. We are proud of our country, but we are not proud of its ineffective laws. Surely it is the duty of Government to provide Americans with every possible defense against disease and death.

IDENTIFICATION BY THE TEETH

No Two Mouths Are Precisely Alike . . . Teeth Have Individual Characteristics . . . Universal Recording System Needed . . . Charts and Technique Available

By EDWARD J. RYAN, B.S., D.D.S.
Editor, *The Dental Digest* and *Oral Hygiene*
Past President of the Chicago Dental Society

THE Tomb of the Unknown Soldier symbolizes the unidentified dead. In the Arlington National Cemetery there are buried 5000 unknown dead of the wars of the United States. In the cemeteries of Europe 1600 crosses without names mark the unknown dead of the World War. Many of these soldier-dead could have been returned to their families for burial if identification by the teeth had been universally practiced.

Each year civilian catastrophes take their toll of lives: An airplane hurtles through the night and strikes the side of a mountain; a school bursts into flames; a factory explodes; a steamship sinks—features have been marred beyond recognition, and only the teeth remain as telltale physical structures.

No two mouths are precisely alike. Even after extraction of all teeth the residual bone retains certain X-ray characteristics, and the distinguishing differences and deviations from the normal may be noted on a chart. Teeth have definite individual characteristics; the relationship of the teeth to one another varies with each person, as do the size and shape of the jaws and palate; the relationship between the two jaws is an important determinant of the appearance of the structures of the lower part of the face. Teeth are, anatomically, square, ovoid, and tapering. Generally speaking, the square type of tooth is found in the corresponding type of face. The shape of the upper central incisor, the shape of the arch, and the shape of the face are usually of the same general type: square, ovoid, or tapering. In any classification of dental tissues, therefore, there is opportunity to record individual tooth size, color, and contour; to record arch sizes and types; to record relationships between the jaws; and, finally, to classify facial types. Thus, from a careful dental description, the lower part of the face of a person sought but unknown can be hypothetically reconstructed with reasonable accuracy.

SPECTACULAR cases, some of which are briefly summarized in the following paragraphs, are on record in which identification by means of the teeth was definitely established, both for civilian needs and criminal urgency.

For example, a radio broadcast recently recounted the story of hill-billies in Kentucky who, unable to write, filed their claims to land by biting a piece of paper in two. Thus in the event of a property dispute the rightful owner could be identified by matching the pieces of paper.

Again, in June, 1935, there was reported the case of Miss Ida May Hanson whom Clarence Neal killed and buried on a Colorado mountainside. Two prospectors in search of gold stumbled upon a stockinged leg protruding from the ground. All efforts at identification of the body failed until the sheriff had a dentist take X rays of the mouth and describe technically the artificial restorations found. Copies of these dental characteristics were distributed at a convention of the Colorado State Dental Association. The story was also published in a national dental magazine. A dentist in Nebraska thought this magazine description to be uncannily familiar. His dental records, including a plaster cast made three years previously, confirmed the identity of the victim whose slayer was soon after apprehended.

A universal system of recording dental characteristics would have made possible identification of this skull

When a skull was found near the former home of a rancher who had disappeared four years previously, the teeth were identified as those of William K. Dowling, the rancher who had, it was decided, committed suicide.

On May 15, 1935, in a wood near Middlebury, Vermont, the decomposed bodies of three persons were found. Through each skull was a bullet hole. The bodies were apparently those of a mother and her two children. The woman must have been about 40 years of age and her children were about 11 and 13. They had lain half buried in the ground for two or three years. Presumably they had been of a prosperous family, for in the mouth of the older child was found a tooth regulating appliance of extremely excellent construction. It would seem that people of this economic class, who could afford such skilful and protracted orthodontic attention, would not vanish without being missed by family and friends. The Boston Police Department, the Boston *Globe*, the Federal Bureau of Investigation, orthodontic societies, and the magazine *Oral Hygiene*, all these have made attempts to identify these people. To date no identification of these bodies has been made. The orthodontic appliance remains the one important tangible clue on which identification depends.

A CORPSE had been claimed as that of John Frahm, wealthy Arizona oil operator. An unidentified body was found with an artificial denture. The dentist's dental chart proved which was the real corpse of John Frahm, and subsequently aided in tracing the murderer.

An autopsy of Alphonso Paolillo who was found dead in the driveway of the home of his cousins in an eastern town, revealed teeth marks on his shoulder. The relatives denied any knowledge of the victim's death, but casts made of their teeth showed that the cast of one of the women corresponded with the marks on the dead man's shoulder.

B. H. Humble of Glasgow, Scotland, an authority on forensic medicine, describes cases of murder committed by sex perverts. These sadists often bite their victims. The bite is usually slowly and deeply inflicted and the tooth marks often persist long after death. In Dusseldorf, Germany, a woman was murdered by such a sex fiend. On her breast were the complete marks of front teeth. The alinement of the marks showed an abnormal position of the incisors. Police authorities made a cast from the marks on the woman's skin, similar to that a dentist makes when he constructs a

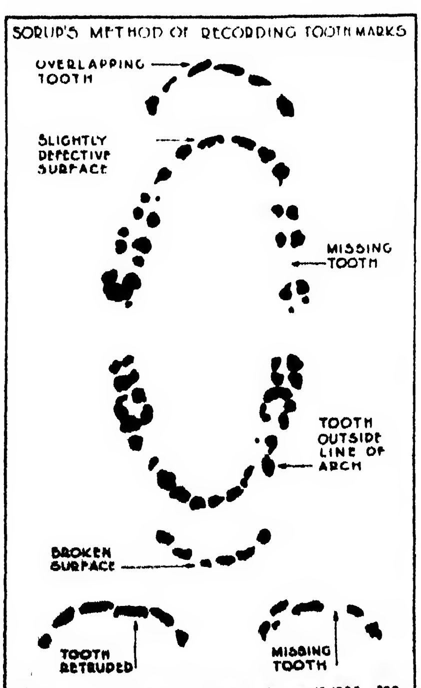
bridge for a patient. This cast was compared with casts made of the teeth of suspects and the identification of the murderer was finally determined from this record.

Sorup, another European interested in this subject, devised a method of recording tooth marks based on the same principle as finger-printing. This method, however, is not practical inasmuch as an ink has not yet been developed to record the tooth impression direct from the mouth; a cast must first be made from which an ink-imprint on paper is obtained.

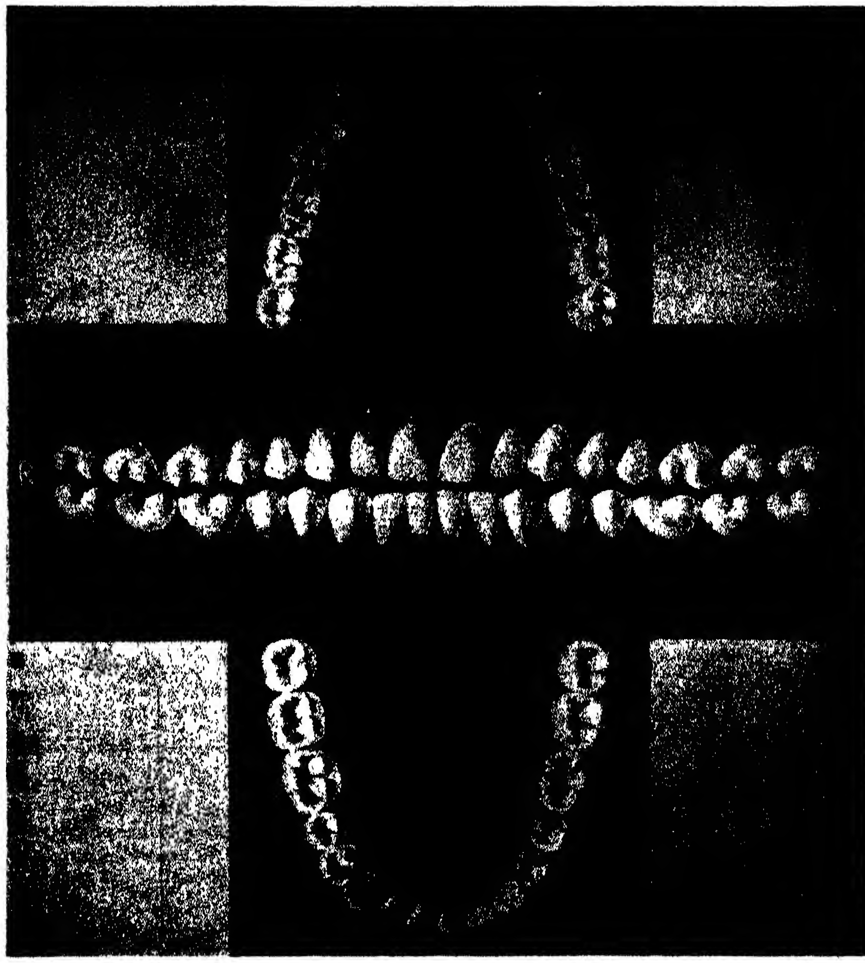
All the identifications cited above were made without the assistance of any universal standardized method of charting the teeth. But if a system of charting, such as that described below, were in wide use, many more unknown dead could be identified.

A record chart, to be generally applicable for such a universal identification system, should have the following characteristics:

1. The teeth should be represented with anatomic accuracy; that is, the size and shape of the teeth should be shown in exact scale and measurement. 2. The chart should show the five exposed tooth surfaces. 3. The teeth should be represented in white on a dark background, so that missing teeth may be recorded by "blacking out" with a soft lead pencil. 4. The chart should be reproduced on a paper that will take colored pencils in order to record metallic restorations of gold and silver amalgam. 5. The chart must be so simplified that it can be filled out and interpreted by non-dentists as well as dentists. 6. The chart must be inexpensive.



Tooth mark record made in ink on paper, from a plaster mouth cast



A standardized chart for recording dental defects and changes

Such a chart has been developed and is reproduced directly above. To date there are at least 100,000 people in the United States who have records of their teeth made on a standardized chart such as is described above. Each one of these persons now has a chart marked in color, in comparatively uniform symbols, showing the following conditions:

1. Porcelain fillings, indicated by a pencil outline. 2. Porcelain jacket crowns and bridge facings, shown by cross-hatching with lead pencil across the corresponding tooth or teeth on the chart. 3. Missing teeth, blocked out with soft lead pencil. 4. Abrasions, represented with soft lead pencil. 5. Cavities, indicated with blue pencil. 6. Advisable restorations, demonstrated with blue pencil. 7. Root canal filling, indicated by red pencil. 8. Pulp involvement, indicated by red at apex of the tooth. 9. Presence and position of an impacted tooth, represented by a red outline. 10. Extraction advised, shown by a red "X" across the proper tooth. 11. Pyorrhea pockets, represented in red along the crest of the gums. (A notation is made at the bottom of the chart if extensive gingivitis is present.)

One would think that the large insurance companies of America, who must have occasional cases in which it is difficult to establish proofs of death because of inability to make positive identification of bodies, would be interested in this subject of accurate and universal charting of the teeth. One would think that these insurance companies would require complete dental examinations as a part of their physical examinations in order to determine the presence of dental disease which might be endangering the heart, the lungs, the kidneys, and all the vital organs. No insurance company in the United States includes a thorough dental examination with the physical examination required, and no dental records are available to aid in establishing the proof of death should other means fail. Such enterprise on the part of insurance companies with their organized facilities for the handling of records would inevitably prove of great value in civilian and criminal identification.

THE chart reproduced above is such that it can be added to at any time. If the patient transfers from one dentist to another, his complete record can be easily transferred also. Already a start has been made. This system is available for routine use in civilian practice with attendant benefits of co-operation between physician and dentist as well as dentist-patient understanding of treatment, in addition to the highly desirable foresight which, in the event of a catastrophe, furnishes a ready means of identification.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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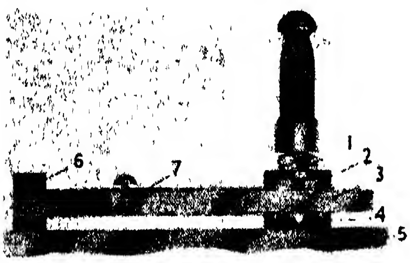
Portable Brinell Tester

A LIGHT weight, portable Brinell instrument that can be carried easily right to the job is said to simplify metal hardness tests around industrial plants and in the field, remote from laboratory facilities. According to the manufacturer it can be used in close quarters and can be applied



Numerals indicate the parts of the Brinell tester described in the text

to parts and equipment the size of which have, heretofore, made testing difficult, expensive, and sometimes virtually impossible. It eliminates both the necessity of dismantling equipment to be tested and transporting specimens to the laboratory.

Known as the Telebrineller, the instrument was developed by one of the oldest and largest railroad rail maintenance organizations in the United States to check and control the re-building (welding) and heat treating of rail ends on the right-of-way. Its simplicity, convenience, and the ease with which it can be carried are indicated by the fact that the combined weight of the outfit and carrying case is only 6½ pounds. According to the manufacturer it is not affected by hot or cold weather and is built to stand hard use. No training or previous experience, it is claimed, is necessary to operate it accurately.

In addition to its more obvious uses in many types of plants throughout the metallurgic industries where it is used both in receiving rooms to check deliveries of raw materials with specifications ordered, and in routine production control, it also has a number of uses in plant maintenance work. Besides its use to test rail ends, it is being used, for example, wherever an accurate knowledge of metal hardness is a factor in safety and continuous operation.

The outfit is composed of the Telebrineller instrument proper, a bar of known hardness, a microscope with a scale etched in its focal plane, and a slide rule, packed with extra test bars and impression balls in a small case. The instrument itself consists of a metal tube supported in a soft rubber head and a rubber spacing block, the tube holding the bar of known hardness. An anvil in the top of the rubber head rests directly on the bar. Below the bar an impression ball, secured in a narrow aperture in the base of the head, comes in direct contact with the metal to be tested.

To make a test the instrument is held against the specimen and the anvil is struck a sharp blow with a three- to five-pound hammer. The impact is transmitted through the anvil to the bar, then to the ball and on to the specimen. Force of the blow is said not to be a factor, the diameter of the impression in the bar and in the specimen being,

Courtesy Teleweld, Inc.

Operation of the hardness tester does not depend on power of blow

A microscope measures the diameters of the impressions; hardness of the material is found by calculation

in any case, relative to their individual Brinell hardness number (BHN).

The diameters of the impressions are then measured in 1/10 millimeters by placing the microscope over each in turn and reading the scale. Figuring the BHN is then a simple matter, using either an arithmetical formula or the slide rule.

NO LYIN'

THE roar of a lion is 100,000,000 times more powerful than the smallest sound that may be heard by the human ear.

A New Synthetic Refractory

FIRE brick and similar refractory materials to withstand high temperatures ordinarily fail in glass-melting furnaces because of the corrosive attack on them of molten glass and slag. A new series of super refractories, recently developed at the Mellon Institute of Industrial Research, has been shown to be as much as six times as resistant to corrosive action of molten glass at 2700 degrees, Fahrenheit, as the best refractories hitherto available. The new materials are cast from a melt produced in the electric furnace at extraordinarily high temperatures. The problem of casting and work-

ing these bricks has been solved by the development of unique methods and the materials are now commercially available. Large-scale applications of "Monofrax," the new material, have already proved it to be outstandingly successful in furnaces for melting glass and for handling molten slag.—*D. H. K.*

FOR FUTURE USE

ALTHOUGH the chemical industry now produces about 10,000 different substances for sale, scientists know definitely of an additional half million substances for which there is no present use.

Boxing the Elements

THE effect of wind, rain, sleet, snow, arctic and tropical temperatures, six-mile altitudes, and power dives upon aeronautical transmitting radio equipment can all be duplicated within a few hours by radio engineers at the General Electric Company, in two new rooms recently completed for radio test purposes.

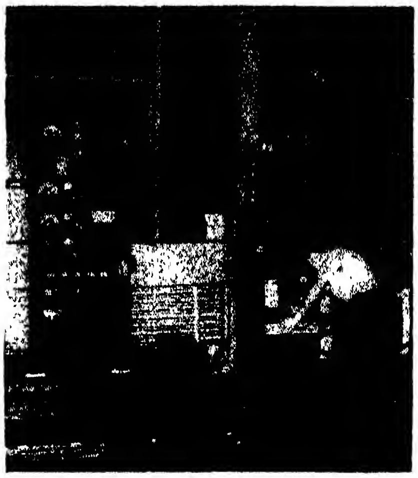
The walls of the two steel rooms where the tests are carried out are 18 inches thick, supported by 12-inch steel beams. Half-inch steel plate covers the exterior with a sheet steel interior protecting insulation of cork and glass wool. Large port holes of one-inch glass permit operators to study the equipment without being subjected to the same strains as are placed upon the apparatus being tested.

The temperature in the "flight room" may be dropped to 40 degrees below zero and raised to 160 degrees above zero. An automatically controlled humidity plant permits the injection of live steam into the room where the effect of a relative humidity from 30 to 100 percent upon the transmitters may be observed.

The air pressure at 30,000 feet elevation is about four pounds per square inch, as compared with 15 pounds at sea level. This high-altitude pressure is created by the use of vacuum pumps which reduce the pressure as desired. The outside air pressure against the room, when the interior has been set to duplicate an altitude of 30,000 feet, is 370 tons, necessitating the heavy, thick steel walls. A pressure of 25 tons is forced against the doors, two feet thick, leading into the rooms.

The effect of wind velocity upon apparatus

Simulated extremes of weather are controlled from this switchboard



A shaking table tests radio equipment for resistance to vibration

is duplicated by two large fans which generate a wind velocity equivalent to 30 miles per hour.

A dry-ice plant provides cold air for the rooms and high temperatures are supplied by five electric heaters with a total capacity of 30 kilowatts.

By being able to maintain temperatures, pressure, and humidity in the rooms, and at the same time being able to change them rapidly, engineers are able to subject apparatus to the same changes it would undergo in a five-mile power dive.

Near the "flight room" is a newly-constructed "shaking machine" for testing the effects of vibration upon aviation radio equipment. The new machine, one of the largest ever built for such purposes, affords precision adjustments of both frequency and amplitude of vibration.

A stroboscope is used with the machine in the vibration tests. By synchronizing the light with the vibration, various parts of the radio apparatus can be studied while in motion.

Such facilities have given radio engineers a new conception of electrical and mechanical designs for radio equipment in filling the need for improved and more efficient apparatus.

Carbon Dioxide Preserves Fruits

BY using carbon dioxide mixtures with air as a preservative atmosphere, such perishable fruits as Australian passion fruit have been shipped to England. The original experiments have proved successful and it is expected that other Australian fruits, including pineapples, may be later shipped around the world in this way. *D. H. K.*

Diver Descends 420 Feet

MAX E. NOHL, diver, who descended to a depth of 420 feet in Lake Michigan recently, withstood a pressure on his body of 320 tons more at that depth than he did at the surface, *Science Service* estimates.

Atmospheric pressure of 15 pounds to the square inch adds up to about twelve tons when all of the 3500 square inches of the average man's skin are considered. At 420 feet the pressure is about 197 pounds to the square inch.

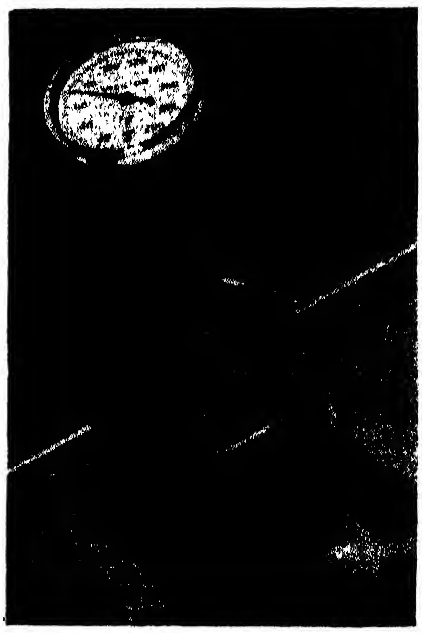
Dissolved gases in the human blood stream and body cells enable us to resist the pressure of the atmosphere. At shallow depths, compressed air helps a diver to resist water pressure, but as the pressure increases, nitrogen from the air dissolves in the blood stream, causing trouble if the diver comes to the surface too rapidly.

"Bends," or caisson disease, a common and serious illness of divers, is caused by nitrogen bubbles collecting in the capillaries. These bubbles act as blood clots. Diver Nohl, to prevent this, used an atmosphere of oxygen and helium, which causes fewer bubbles in the capillaries on ascending to the surface. If he descends to a depth of 500 feet, as he plans to do in another dive, the pressure will be 380 tons more than at the surface.

Stainless Steel Thermometer

AN entirely new type of laboratory thermometer, provided with a dial-and-pointer scale encased in stainless steel, mounted on top of an eight-inch stainless steel stem, is being introduced by the Weston Electrical Instrument Corporation.

The unit is said to be the first dial-type thermometer with an all-metal temperature element sufficiently accurate for scientific use. The pointer is actuated by means of an internally balanced double coil of thermostatic bimetal sealed in the lower 1½

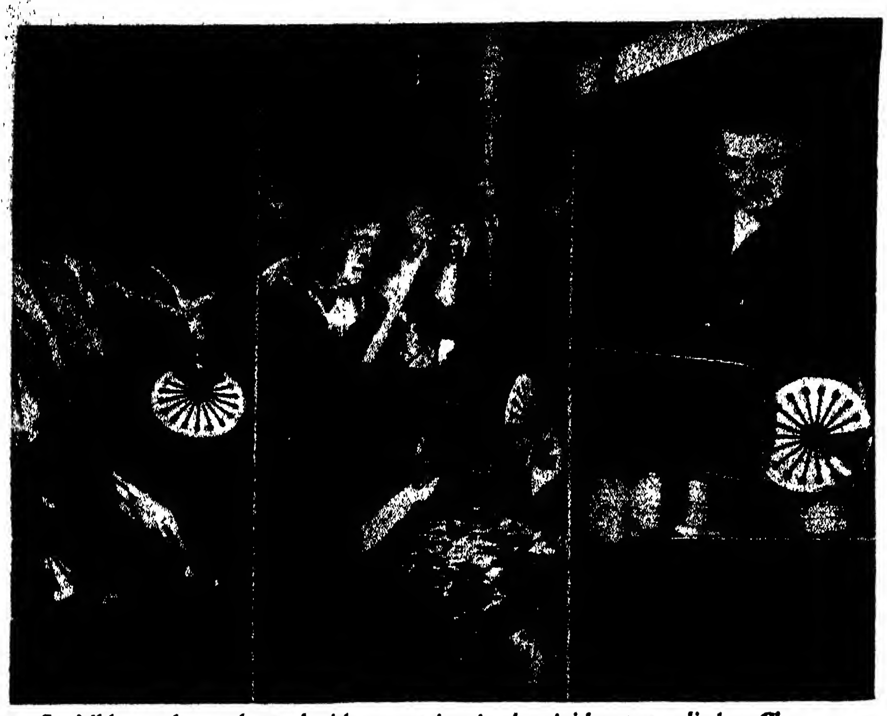


A dial-reading thermometer

inches of the seamless stem. When the stem is immersed to a depth of 1½ inches in a liquid (three inches in gas or vapor) the dial reads temperature values accurately without the necessity for stem correction.

Accuracy of the unit is guaranteed to ½ of 1 percent over the entire scale. In practice, the location of the dial at the top of the stem, removed from the liquids or vapors under measurement, encourages a further increase in the accuracy with which readings are made. Dial markings are spaced for maximum readability on the metal scale plate, and are not subject to obliteration from the solutions under test, as is the case with stem graduations. The low temperature values are not obscured in dark-colored solutions.

Initial models of the unit are being offered



Invisible cracks are hunted with magnetism in the rigid tests applied to Chevrolet's new disk-type clutch spring. At the left an operator is magnetizing a clutch spring by placing it in a powerful magnetic field. In the center picture a rack of magnetized springs is being dipped in a bath containing iron dust in suspension. When the rack is removed the springs are washed and inspected by the operator at the right. Fine iron dust will adhere to the edges of any crack, showing up as a thin line on the surface. If the spring is perfect, it is rolled down a chute, where powerful magnets create another field that demagnetizes the disk. By this method it is possible to locate small checks and cracks that are invisible to the unaided eye

in the following scale ranges: 0 to 220 degrees, 50 to 300 degrees, and 50 to 500 degrees Fahrenheit; and 0 to 100 degrees, and 0 to 150 degrees Centigrade. Applications include temperature measurement in educational and industrial research laboratories, in control laboratories, in hospitals, and in general scientific use.

A Truck Fortress

EXPRESSING the ultimate in safety and protection is a new armored car just delivered to the Union Bank and Trust Company of Los Angeles. With a body of new type construction, this vehicle, built by Mack, has an outer shell of ordinary soft body steel. Beyond this is a two-inch layer of special insulating material under which is special bullet-proof steel. The hood is afforded good protection by an inner bullet-proof shell, and gun ports are protected from the inside by bullet-proof sliding doors. By the use of soft steel on the outside of the body, bystanders are protected from ricocheting bullets, and the shot also loses part of its power before coming into contact with the insulation. All windows are protected by special multiplate bullet-proof glass, one and one-half inches thick.

An unusual feature of this unit is a conning tower at the rear which enables the guard there to have a 360-degree range of fire. Firing down and alongside the truck is possible through a gun port in the lower corner of the glass frame of the conning tower; hence there are no blind spots. A brake lever and an ignition switch in the conning tower give its occupant partial control of the truck from that point.

Divided into three compartments—that of the driver, the center one where money and securities are stored, and the rear conning tower—all of these compartments have intercommunicating telephones and are air-tight, thereby making it possible for the occupants of the vehicle to resist a gas attack for at least a half hour before suffocating. Equipment for this unit includes two electric fans, sawed-off shotguns, high-powered rifles, hand grenades, and gas bombs.

Cyclohexylamine

WHEN aniline, familiar as the parent of dyes, is treated with hydrogen in the presence of a catalyst it is converted into a very different compound known as cyclohexylamine. Although this fact has been known for more than 40 years it is only now becoming commercially important. Lately this compound and many of its derivatives have been shown to be valuable in industry. One important group of derivatives has been found to include valuable insecticides. Another group contains important plasticizers for use with synthetic resins. A third group prevents corrosion by alcohol solutions in automobile radiators. Still other derivatives are useful in rubber compounding, as dyestuffs, and as soaps, particularly for use in dry cleaning.—*D. H. K.*

CHIPS

RANCIDITY in potato chips is checked by dusting finely ground oat flour over the surface of the chips.

Brunettes Should Spray Tar—with Cellophane Masks

TAR sprays used in controlling certain pests that attack fruit trees are caustic to the skin of men and horses, and precautions must be taken to avoid injury. The causticity varies with conditions and individuals. In general, blondes are more susceptible to injury than brunettes, and hence brunettes should comprise the spray crew whenever possible. Again, tar sprays produce a severer irritation in sunlight than in shade, and hence night spraying or spraying on overcast days will avoid some injury. Sprayers should protect all parts of their bodies from the spray. Spray coats, gloves, and hats should be worn, and the face should be protected with a sheet of moisture-proof Cellophane wedged under the hat band. As the spray covers the Cellophane and clouds the vision, additional clear space can be pulled out of the hat. Usually a fresh piece of Cellophane will be needed for each tank of material. Attempts to protect the face with creams and greases have proved unsuccessful. Some sprayers, however, claim that protection is obtained by the use of such materials.

There is a tendency among sprayers to discard protective clothing and masks on the basis that they hamper their vision and action, or that such protection is unmanly.

This fortress on wheels is virtually bandit-proof

Industrial Prospects Come Thick and Fast

When Appealing to the RIGHT Guiding Executives and Research Technicians

EVEN your star salesmen are blocked again and again because they fail to reach the influential people who decide on Industry's purchases.

But even your average salesman can get the top-notch orders with carefully planned "behind-the-scenes" selling, done before he reaches his prospects.

An advertising campaign in Scientific American lays the ground work for such selling technique, does wonders by making a difficult sales task a simple one. It penetrates to the ideal reader combination:

To those who make the purchase recommendations—the industrial executive heads, the key research technicians in the mechanical and chemical laboratories, engineers, chemists, physicists, metallurgists, and so on.

Those men are your RIGHT customers. They are the ones who focus their undivided reading in Scientific American to get first knowledge of the developments in industry and science—obtaining valuable information which they use in the development of their own products.

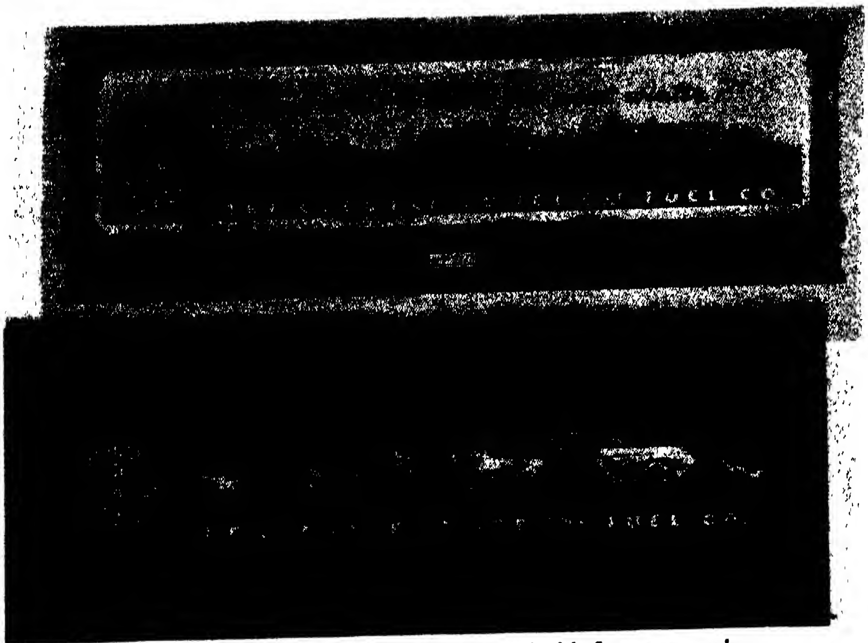
Therefore, Scientific American readers, observing technical improvements which benefit them, read Scientific American advertising pages too . . . purposefully.

Here's one example of results: $1,688.50 of industrial scales sold through a $100 advertising investment in Scientific American—a small 6% selling cost!

If you are selling to industry, large or small, whether your prospects are few or many, Scientific American can help sell your product. Let us give you further facts.

SCIENTIFIC AMERICAN

"A Compact Circulation of Leaders in Industry, Research and Science"



Day and night views of a signboard painted with fluorescent colors

This is a serious mistake. The possible injury from tar sprays should not be taken lightly. The writer has seen several men severely burned, and one required hospitalization. The fact that one man experiences no difficulty is no clue to the susceptibility of his co-workers. Each man should determine to his own satisfaction whether or not he is susceptible. It should be borne in mind that the burning sensation does not arise immediately after an application of tar to the skin, but rather will reach a maximum some two to four hours later. *-Dr. Leslie M. Smith.*

Fluorescing Outdoor Signboards

DURING the past several years the question has been asked frequently whether fluorescent materials, applied to outdoor advertising and activated by ultra-violet light, are feasible and practical, in view of their appeal to the American's well-known desire for novelty.

In discussing this question recently, G. R. LaWall, of the General Electric Company, says that hitherto the lack of suitable ultra-violet sources and also the lack of fluorescent materials had prevented this application but adds that such interesting effects seem now within reach of the outdoor advertising world

Suitable ultra-violet lights are now available and a line of fluorescent inks and lacquers in white, blue, and green has been developed by the Continental Lithograph Corporation. Tests have shown that in actual use outdoors no appreciable deterioration has taken place though this new medium is recommended only for bulletins at the present time.

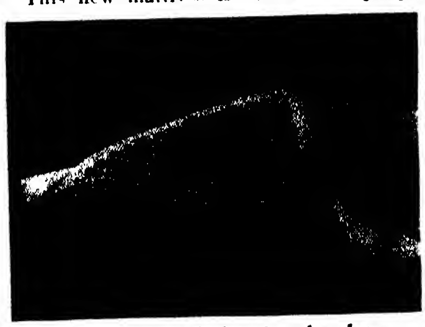
These fluorescent inks and lacquers offer new animation possibilities without complicated mechanism. At night, ordinary incandescent lamps in shielded reflectors display a sign as a whole. As these flash off and ultra-violet lights go on, that part of the sign which has been picked out with the new fluorescent materials will glow in brilliant hues while the remainder of the sign cannot be seen. During the day, the fluorescent materials are invisible and do not interfere in any way with the sign as a whole.

This development offers a new field for the creative designer and has a new nighttime appeal where the advertiser desires the unusual, the distinctive, and the novel.

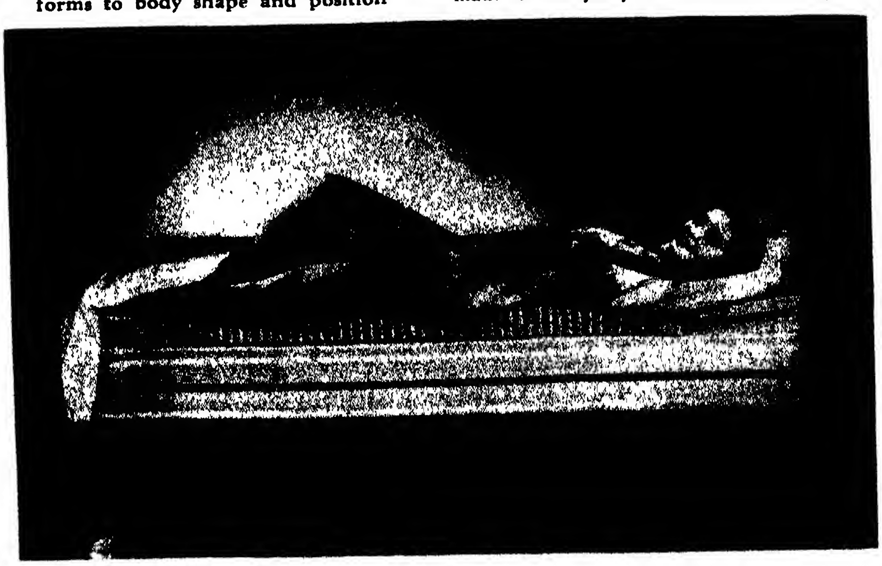
Now the Sleep-Cushion

A NEW and entirely different type of mattress, to be known as the Red Ball Sleep-Cushion, was announced recently by the Mishawaka Rubber and Woolen Manufacturing Company.

This new mattress is formed of sponge rubber made of latex, the milk of the rubber tree, whipped to a foam and vulcanized in a single piece. It is made in bed sizes, is about five inches thick, and for additional springiness and ventilation is pierced by finger-sized holes in an all-over pattern. The Sleep-Cushion is actually about 85 percent air and 15 percent pure rubber so that it weighs only about half as much as the ordinary mattress.



***Above:* Note holes in the latex sponge-rubber Sleep-Cushion. *Below:* The all-rubber mattress conforms to body shape and position**



This new type of material eliminates padding, springs, wires, tufts, or buttons, and has a perfectly smooth surface. A cloth cover fits smoothly over the cushion. Since the material used is much softer than the body, the mattress conforms perfectly to all sleeping positions, shaping itself to every contour. When compressed, its tiny air cells release their air and then fill again as the pressure is changed or lifted, so that the mattress virtually "breathes."

SMOKE

SMOKE in the atmosphere costs each person in the United States from 10 to 30 dollars annually. This expense is due to clothes cleaning, disfigurement of buildings, damaged merchandise, injuries to grass and plants, and the loss of visible and ultra-violet light.

Blueprinting through Ordinary Paper

BY treating ordinary typewriter paper with a solution of diethyl phthalate (a synthetic material used to soften cellulose acetate and as a fixative in perfumes), it can be rendered transparent enough to allow blueprints to be made through it. Letters, drawings, and handwritten documents can be easily copied by the blueprinting process after they have been treated in this manner.—*D. H. K.*

Lightning Behavior

LIGHTNING may strike a tree, travel to the ground, but if the soil happens to be of gravel or of a poor conductor type, it is likely to bounce out again and do further destructive work until it finds a ground of less resistance. This announcement was made recently by K. B. McEachron, in

The Editors Recommend

Best Sellers in Science

Books for the Technically Minded

1. **SCIENCE EXPERIENCES WITH HOME EQUIPMENT**—*By C. J. Lynde.*
A book of 200 simple home tricks based on physical laws, each experiment being illustrated and its principle explained.—$1.35 postpaid.

2. **NEW FRONTIERS OF THE MIND**—*By J. B. Rhine.*
In plain, straightforward, and entertaining style, the experiments at Duke University (ESP) are discussed in this volume. Plain science, no mysticism.—$2.65 postpaid.

3. **THE HANDY MAN'S HANDBOOK**—*By C. T. Schaefer.*
Fourth edition of a very popular book a practical manual on the use of tools and how to do all sorts of odd jobs around the home. $1.15 postpaid

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A chunky book of nearly 700 pages, giving the details of world navies with many pictures. A fine reference giving all manner of details.—$3.20 postpaid.

5. **ABC OF AGROBIOLOGY**—*By O. W. Willcox, Ph.D.*
A treatise on plant culture, laws of nutrition and quantitative growth, soil fertility, and soil science. $2.90 postpaid

6. **AIR CONDITIONING IN THE HOME**—*By Elmer Torok, M.E.*
Fundamental principles of air conditioning. Various kinds of equipment and what each will do, and how the equipment is installed and operated.—$3.20 postpaid.

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Theory, aerodynamics, and propeller design of model airplanes. Professor Klemin says that even the well-informed aeronautical engineer can learn something from its pages $1.15 postpaid

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A popular and most readable exposition of chemistry in relation to modern life and industry Equally as interesting to the layman as to the chemist.—$3.20 postpaid.

9. **CYCLOPEDIA OF FORMULAS**—*By Albert A. Hopkins.*
A standard reference indispensable in the laboratory, shop or home. Over 15,000 formulas covering every conceivable field of work $5.50 postpaid.

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A thoroughly practical home instruction book which tells the amateur how to make astronomical telescopes capable of doing serious work at about 10 percent of the purchase cost of finished instruments At least 10,000 amateurs have made their own telescopes from this standard manual and guide $3.00 postpaid

11. **AMATEUR TELESCOPE MAKING—ADVANCED**—1st Edition (1937)—*Edited by Albert G. Ingalls.*
A sequel to "Amateur Telescope Making," for especially enthusiastic followers of the hobby who already have A T M and now seek new worlds to conquer, such as special tests, eye-piece making, camera obscuras, sidereal clocks, astronomical micrometers, chronographs $3.00 postpaid

12. **THE FINGER PRINT INSTRUCTOR**—Revised Ed.—*By Frederick Kuhne.*
Taking finger impression, comparison of prints, methods of filing, and so on, are here presented in a logical sequence, just as they would be used in actual practice. Indispensable to detectives, criminal lawyers and criminology students —$3.25 postpaid

13. **NEW WAYS IN PHOTOGRAPHY**—*By Jacob Deschin.*
The whole range of amateur photography including such things as trick photography, photomurals, retouching, infra-red, and a number of other divisions that will not be found elsewhere discussed in as clear and concise a manner.—$2.90 postpaid

14. **MAKING PICTURES WITH THE MINIATURE CAMERA**—*By Jacob Deschin.*
Packed solely with how-to-do-it material no frills, all meat and bones. Tells exactly how to handle your camera under varying conditions. Light, composition, and technique are stressed 19 full page photographs —$3.15 postpaid.

15. **ZERO TO EIGHTY**—*By Dr. E. F. Northrup.*
A great scientist discusses with much imagination but with a solid scientific foundation a trip to the moon, his own experiments, and inventions made to prove his theory. Many scientists have called this an enthralling volume.—$3.20 postpaid

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Not a book but a cardboard, printed, rotating device which automatically shows the stars as seen at any hour in the year. A help in learning the constellations. (Formerly 85 cents)—60 cents postpaid

17. **WALKER ON PATENTS**—*Deller's Edition.*
Completely rewritten and enlarged by Anthony William Deller, this 4-volume set tells just about all that one may desire to know concerning patents and patent litigation.—$50.00 a set plus shipping charges.

18. **WILD FLOWERS**—*By Homer D. House.*
This superb book has 364 color plates and 340 pages of text. Hundreds of wild flowers in all parts of the United States can be identified through the pictures and the descriptions which were written by this noted authority. Formerly $7.50. Now $4.45 postpaid.

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Contains over 100 complete and easily followed instructions for tricks of parlor magic A bound-in envelope contains all the actual apparatus needed for these tricks.—$3.25 postpaid.

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Inarticulate people will be tremendously helped by the reading of this book by a man who is a brilliant conversationalist It will help remove that inferiority complex.—$2.65 postpaid.

21. **THE BIRDS OF AMERICA**—*By John James Audubon.*
For the first time, about one hundred years after their first publication, Audubon's extraordinarily beautiful paintings of the birds of America are collected in one volume Contains 500 plates, faithfully reproduced in original colors and a brief discussion of the range, habitat, and identification characteristics of each bird shown. Each plate is on a separate page 9 by 12½ inches and the volume is bound in attractive, strong buckram. Packed for shipping, weighs 7½ pounds.—$13.00 postpaid.

22. **FREEHAND AND PERSPECTIVE DRAWING**—*By Herbert E. Everett and William H. Lawrence.*
An explanation of the perspective of simple forms and more complicated ones such as, for example, a many-gabled house, elaborate column capitals, and floral designs. $1.65 postpaid.

23. **PHOTO-MARKETS** (Seventh edition).
A "make money with your camera" book of 112 pages telling what to shoot, how and where, with directions for submitting photographs to magazines Over 1800 markets listed. 50 cents postpaid

24. **SHIPS OF THE WORLD'S BATTLEFLEETS**—*Edited by Pay-Lieut. Comdr. E. C. Talbot-Booth, R.N.R.*
Essential facts regarding the principal ships in the navies of the important powers, with details of construction, silhouette drawings, and a large number of photographs. $1.65 postpaid.

25. **MATHEMATICS FOR THE MILLION**—*By Lancelot Hogben, F.R.S.*
A book by a scientist not primarily a mathematician, intended as a help to millions who have "forgotten their mathematics". For laymen who would like to remember easily. $3.95 postpaid

26. **THE MYSTERIOUS UNIVERSE**—*By Sir James Jeans.*
Covers a remarkably broad territory, touching on everything new in modern physics, astrophysics, and cosmology. Many men of science now are leaning toward a non-materialistic interpretation of the universe and Jeans is one of these. Formerly $2.40. Now $1.15 postpaid.

27. **THE ROMANCE OF ASTRONOMY**—*By Florence A. Grondal.*
The author writes for the average reader who would like to know more about the stars and the planets Her book brings to life the facts of astronomy through picture and story. Illustrated with striking photographs and diagrams Formerly $5.00 Now $1.85 postpaid.

28. **SNAKES OF THE WORLD**—*By Raymond L. Ditmars.*
Probably the most readable, attractive and extensive discussion of the subject yet offered to the general reader. It discusses the more than 2000 different kinds of snakes. A superb collection of illustrations - Formerly $6.00 Now $2.10 postpaid

29. **SAILING CRAFT**—*By Edwin J. Schoettle and Others.*
An authoritative account of sailing craft by experts Chapters on boat designing, catboats, racing scows, 15- and 20-foot sneaks, Wee Scots, models and the sailing of models, etc. A book for everyone who likes boats, sails boats, or owns a boat —Illustrated - Formerly $12.00. Now $2.75 postpaid

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charge of General Electric's artificial lightning and high voltage laboratory, who has observed several occurrences of this character in connection with his recent investigation of lightning. In one of these cases, lightning came down a 90-foot pine tree and plowed up a furrow in the ground until it reached a pole supporting telephone wires. It went up the pole, leaving some splintered wood behind, and finally found its ground connection after passing through the telephone wires.

In another case, in New Hampshire, lightning followed down a tree, traveled a distance of approximately 50 feet over the earth to pass up another tree, then jumped approximately one foot to a 110-volt lighting circuit, from which it dissipated itself in lightning arresters connected to the power circuit.

The three main hazards of standing under a tree during a storm are: (1) the discharge may side-flash from the tree; (2) the discharge in passing through high-resistance soil at the base of the tree may pass considerable current up one leg of a person and down the other, often the reason why cattle are killed under trees; (3) the tree may explode and a person may be injured by the flying debris.—*Journal of Applied Physics.*

FOR GOATS?

A FATTENING food for livestock, consisting of bran middlings soaked with edible palm oil, is produced by steel mills as a by-product of tin plate manufacture. —*Steel Facts.*

Synthetic Perfumes Excel

THE synthetic perfumes of modern ten-cent stores excel those for which perilous sea voyages and hazardous caravans probed the Orient in the Middle Ages, Dr. Charles F. H. Allen, of the Eastman Kodak Company, declared at a recent meeting of the American Chemical Society.

America's beauty bill, he added, annually runs to over 200,000,000 dollars, even when a most conservative estimate is taken. Much of this is profit; for, said the scientist, the jar containing the cosmetic may well be the most expensive part. For example: jar, six cents; contents, two cents.

Synthetic perfumes duplicate natural perfumes in everything but cost. Natural oil of rose costs 175 dollars a pound, while the same product, made in the laboratory, costs only $22.50 a pound.—*Science Service.*

Dyes Test Bay Currents

FOR the purpose of determining the extent and the location of the sewerage field from the proposed sewerage outfall of Treasure Island, site of the 1939 Golden Gate International Exposition on San Francisco Bay, novel and interesting tests were made with aniline dyes.

In tracing the currents, uranin, a little used German type dye now manufactured in limited quantities in this country, was used to color the water. So penetrating is red uranin that one pound of this powder will color 10,000,000 pounds of water. Originally

this dye was used in Germany to trace the course of underground currents. Recently uranin was used by California sanitary engineers in making sewerage tests at Monterey, Santa Cruz, and Santa Barbara.

During tests, one pound of red uranin released from the engineers' boat on the ebb tide colored an area of several acres a light greenish hue which could be readily distinguished from the San Francisco-Oakland Bay Bridge, a distance of several miles. Several other markings were made on both the outgoing and incoming tides.

Tests were started at 10:00 A.M. on the ebb tide with a one-pound release of uranin. The next marking, a two-pound release, was at 11:15 on the slack just before the flood tide. Half pound quantities were released at 11:30, 11:45, and then every half hour until two o'clock. Currents were plotted by observers located on the cantilever span of the bridge.

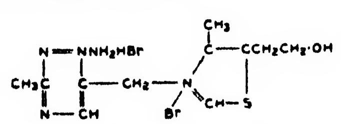
In charting the course of these colored areas it was noted that the 20,000,000 cubic-yard fill of the Exposition site, the world's largest man-made island, had considerably altered the currents of San Francisco Bay. Location of the Exposition's outfall sewers will be determined by the tests.

COTTON

ONE thirty-second of an inch is barely discernible to the eye, but just that much added to the average staple length of cotton should mean in excess of 8,000,000 dollars more in the pockets of the growers in one year.

Synthesis of Beri-Beri Vitamin

AFTER 26 years of constant research, the vitamin preventive of the disease beri-beri has been isolated, its chemical constitution determined and the vitamin itself synthesized at a cost far lower than that of recovering it from bran. The chemical formula of the vitamin as given before the American Chemical Society by Dr. R. R. Williams, to whom credit is largely due for this accomplishment, is:



In describing the significance of a bountiful supply of this pure vitamin, Dr. Williams said, in part:

"Now that the vitamin is abundantly available, what uses will it serve? First, we should mention the knowledge it will bring of the physiological function of this substance which is required for the growth and well-being of all living things, both plant and animal. Yeast, bacteria, mushrooms, peas, tomatoes, beetles, birds, goats, monkeys, rabbits, rats, mice, and men have all been shown experimentally to use it as part of their normal processes. . . . A better knowledge of its behavior will broaden the new science and in many ways assist in the mastery of constitutional diseases, notably neuritis, arthritis, and gout.

"Certain practical and immediate uses

are already evident. Although we have known for more than 20 years the cause and means of preventing beri-beri, relatively little has been done in the Orient to curb it except perhaps in the Dutch East Indies. Until the sale of polished rice is prohibited or restricted in the East, as has often been proposed by sanitarians, the disease will flourish and there will be need for treating it. . . . The number of people who are partly incapacitated by beri-beri is much larger than the number who die. One authority estimates the total number of current cases in the Philippines at 150,000."

SUPER-NOVA

A SUPER-NOVA discovered early in September by Dr. Fritz Zwicky is so distant that it appears to the eye as only a faint telescopic star of magnitude 10.5, despite the fact that it is actually five hundred million times brighter than the sun.

AIRCRAFT AND THE MERCHANT MARINE

BEGINNING his aeronautical career as Chief Engineer to the Wright Brothers, Grover Loening has passed from one success to another, as a designer, constructor, and manufacturer of outstanding land planes and seaplanes. His recent report to the Maritime Commission, entitled "Aircraft and the Merchant Marine," lives up fully to this background, analyzes the whole situation admirably, and lays the foundations for a real policy in the use of the aircraft in transoceanic service.

Thirty years have elapsed since the *Mauretania* established its Atlantic record of 5 days and 2 hours. The *Normandie* has succeeded in lowering that time by only 24 hours. If the horsepower of the *Normandie* were doubled, at prohibitive expense, the time of crossing the Atlantic would be reduced only 11 hours.

Against this practical limitation on surface vessel speed, there is the certainty that, in the immediate future, we shall have flying boats of 120,000 pounds gross weight, carrying 40 to 50 passengers at an average speed of 175 miles per hour, and with a 5000 mile non-stop range.

The question of safety immediately enters the discussion. The report makes a fair and well-founded presentation, summarized below, of the argument that the safety and reliability of the flying boat are such as to make its service entirely practicable:

1. Pan American Airways have completed a year of operations between San Francisco and Honolulu—an over-water jump of 2400 miles—with a record of 96 percent completion of previously announced schedules.

2. The elimination of intermediate landings in the Atlantic will make for a reduction of take-off and landing risks, and will give a wide choice of routes to find the best weather or the shortest air distance.

3. During the winter, ice conditions may hinder take-offs and landings in New York so as to require operation from Baltimore or Norfolk, but the flying boat needs so little in the way of ground facilities that seasonal shifting of bases is entirely practicable.

4. In foggy weather, the take-off need not

be delayed because a quick climb to clear air can be made safely from a patrolled section of the water. Once above the thick weather, radio and celestial navigation make it possible to continue the voyage with safety.

5. The high cruising speed makes a gale of little importance; continuous head winds of 40 miles an hour can be overcome, thunder-storms are an ineffective commonplace to fast aircraft, and weather reporting makes hurricanes avoidable, or, in some cases, actually helpful.

6. With flying boats of the large size, ocean landings and take-offs under calm conditions are practicable. In a storm, landings can be made with injury to aircraft but none to personnel. Moreover, with four or even six motors, the possibility of forced landings becomes remote.

With flight at a height of only 10,000 feet, bumpy air over the ocean is unlikely. In the matter of space, accommodations, quiet, the overland airliners are already equal if not superior to Pullman trains. In the large flying boats, future designs offer passenger comforts almost equal to those of the *Normandie* or the *Queen Mary*. With overnight runs instead of four or five days on the sea, air travelers are not likely to demand swimming pools, though Igor Sikorsky is quite certain that a dinner dance will be an appropriate accompaniment of flying-boat travel across the Atlantic!

The Maritime Commission has made a fine study of our Merchant Marine problems, and there is no doubt that the nation is in sympathy with its objectives, even though there may be differences of opinion as to methods. One of the problems which the Maritime Commission has considered is: Shall we build superliners, or airships, or large flying boats to maintain our competitive position in ocean travel and service? Mr. Loening approaches this problem in realistic and factual fashion.

We can plan for one superliner making one crossing per week; two airships making 1½ day crossings on seasonal schedules of two to four per week; or six flying boats making daily crossings both ways.

The superliner will cost 50,000,000 dollars. The construction cost of an equivalent passenger capacity in dirigibles would be about the same. The cost of equivalent passenger capacity in flying boats is estimated at 1,800,000 dollars. The items of depreciation, fuel, and crew cost of the three major methods of crossing the Atlantic give an equally interesting comparison. The superliner figures out to $67.58 per passenger, the dirigible to $131.83, and the flying boat to $73.10.

Therefore, in addition to its superiority in speed, the flying boat adds lesser initial cost, and not much greater operational cost than that of the superliner. But will the flying boat attract sufficient sources of revenue? The volume of transatlantic first-class mail is approximately 8000 pounds per day, and the average number of first-class passengers paying something like the proposed airplane fare of 450 dollars is 20,000 a year. There will be no difficulty in securing revenue. The temptation of a week-end in Paris, let us say, will certainly increase the volume of passenger travel. Mail would, of course, increase enormously and perhaps cut in quite seriously on cable communications. To quote Mr. Loening's own words:

"It would appear, therefore, that these services (one day to Europe by airplane and 2½ days by dirigible) may in the near future be operated at a cost and a fare equal to or possibly less than that of a superliner. Such faster services, with ample capacity for a large part of the passenger, mail, and express traffic, will cause superliner service to lose much of its appeal and justification for a large class of traffic."

There is a well-founded warning to shipping companies in the report: "If the shipping companies are not to add aircraft to their fleets, they will undoubtedly lose considerable traffic to independent airline companies. The ocean-going flying boat or dirigible is nothing less than another vessel—a very much faster vessel—and eventually cheaper to operate. For shipping companies not to make use of this new vessel on their trade routes may prove quite short-sighted."

Space will not permit us to review the discussion of airships as an alternative to flying boats, but it is clear that Mr. Loening's well considered and unbiassed opinion rules the airship out from serious consideration.

To date Pan American Airways have done very well without much government aid, except in the matter of mail charges. But if aircraft are to have a definite place in our over-seas trade, and if we are to meet the liberal subsidies of the British to their Imperial Airways, of the Germans to Luft-Hansa, and so forth, then an extension of the Merchant Marine Act of 1936 to include aircraft is legitimate and desirable. For the large flying boats discussed above, the initial engineering and development costs are enormous. The risk assumed by the manufacturer in taking an order, and by the operating company in giving an order, are very high.

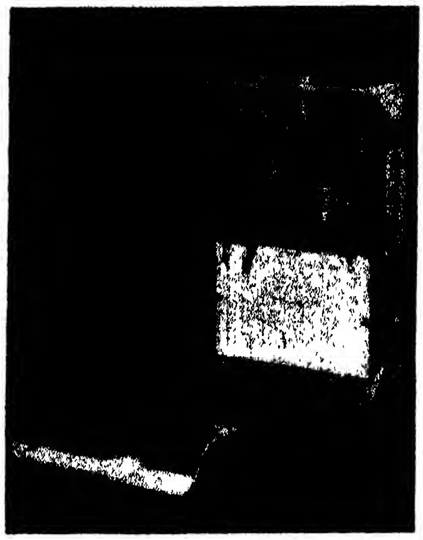
The Merchant Marine Act should be modified to permit 75 percent construction loans on aircraft for the foreign trade. This would give our transatlantic air services just the encouragement they need. And while European surface vessels cost less to build than American surface vessels, the situation is reversed in the case of flying boats, owing to our better production methods. With initial help in the form of construction loans, our flying boat constructors and our splendid operators would know perfectly well how to withstand all foreign competitors. The importance of this matter from the point of view of national trade and national defense is so obvious that it needs no argument. *A. K.*

POTSHERDS

IT is undoubtedly true that the pitcher that goes too often to the well is the one that is broken, but it is also true that it is the one that is saved for posterity.—*C. K. Wilkenson, of the Iranian archeological expedition of the Metropolitan Museum of Art.*

FLIGHT ANALYZERS AT WORK

CONCEIVED by Major R. W. Schroeder and developed by the Julien P. Friez Company, 60 flight analyzers are now in service on United Air Lines. The charts of the flight analyzer give a check on the pilot,



Interior of the flight analyzer that keeps careful and accurate check on the operation of transport planes

particularly as regards the observance of the rule that flight shall be at a minimum of 2000 feet. From these charts also, dispatchers, chief pilots, and other operators will be able to reconstruct the history of any flight and learn much about the efficiency of operation.

The flight analyzer is housed in a small case made of duralumin and weighs only three pounds. The charts are three by five inches in size. Prior to a flight a fresh chart is placed on a special rack, which is geared to a clock mechanism. The chart is thus moved at such a rate that the recording pens move across the time divisions of the chart in exact ratio to the actual passage of time. Pens are carefully adjusted and the device is placed behind the express compartment near the tail of the plane. The range of the analyzer is eight hours, which covers the longest over-land flight undertaken.

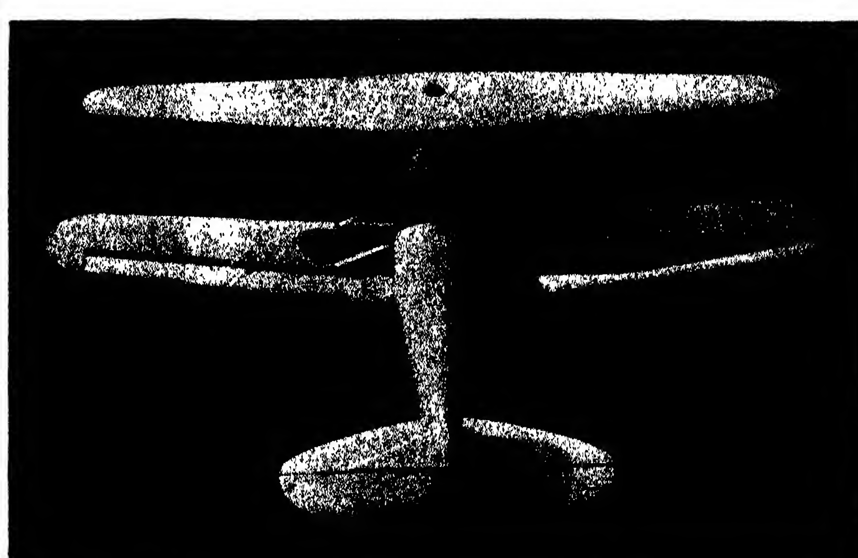
The barographic part of the analyzer will give a record of altitude against time, so that rates of climb and descent can be checked, and will also serve to indicate gustiness. The barograph will also indicate whether the 2000 feet rule has been observed. Certain recording arms actuated by electric impulses chart the length of time that the automatic pilot is in use, and the number and duration of radio contacts with ground stations.

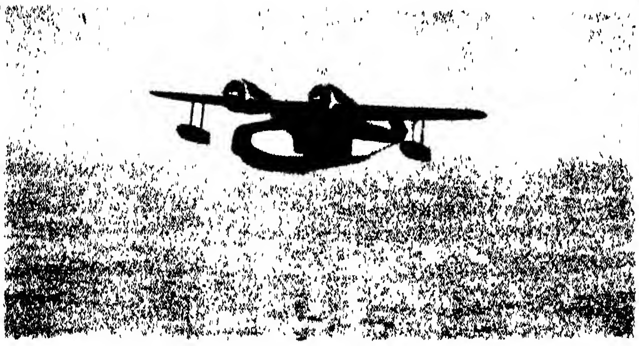
It will be readily agreed that the analyzers will provide a wealth of useful information for the air transport operator.—*A. K.*

The Herrick Vertaplane

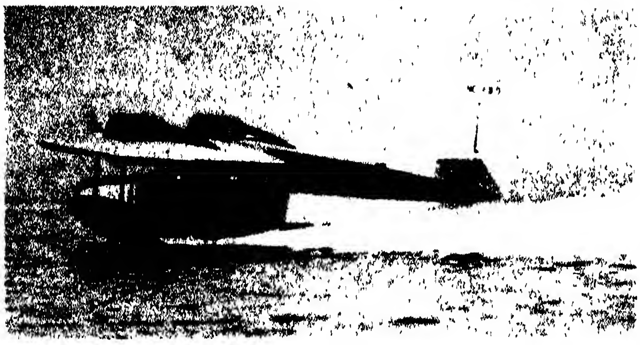
The airplane wing is at present and is long likely to remain the most efficient form of lifting surface, far more efficient than any rotary wing or system. On the other hand, the rotary airfoil has such enormous lifting capacity that it robs emergency landings or landings in restricted territory of their terrors. It is the ingenious idea of Gerard P. Herrick to combine the efficiency of the fixed wing with the ideal landing characteristics of the rotor. A good many years of patient research work and skilled engineering and construction have resulted in highly successful tests of the Herrick Vertaplane, as the new type of aircraft is termed. The upper wing of the Vertaplane is a special, symmetrical airfoil—that is, with the leading edge identical with the rear edge. This wing is mounted on a horizontal

Above: **Releasing mechanism of the upper wing of the Vertaplane.** ***Below:*** **The Vertaplane on the ground, showing the symmetrical airfoil design of the rotatable upper wing**





One of the new amphibians for private flyers, many of which were bought from drawings



The Grumman amphibian about to take off from the waters of Long Island Sound

hinge, placed at the top of a strut mounting. When the pilot so desires, certain of the struts are released and an electric starter and suitable gearing rapidly set the wing into rotation, giving it all the characteristics of the rotor. Shock absorbers take up the initial moments that are developed.

The Vertaplane has been converted in flight some seven times at heights of one foot, ten feet, 20 feet, 50 feet, 100 feet, and 1500 feet from the ground. The starting of the rotor and the conversion generally occur so rapidly as to be scarcely noticeable. While this particular ship was built to demonstrate the simplicity and practicability of conversion in the air, and is therefore subject to considerable refinement as to weight and parasitic drag, it has shown quite satisfactory performance as a fixed wing biplane, with a maximum speed of approximately 100 miles per hour. Its landings have been very slow.

The general characteristics of the Vertaplane HV-2A are as follows: Span of rotor wing, 24 feet; lower wing span, 28 feet; area of upper wing, 70 square feet; area of lower wing, 100 square feet; disk area, upper wing, 452.4 square feet; airfoil of upper wing, Herrick 7-11; airfoil of lower wing, Clark Y-15; engine, Kinner B5 of 125 horsepower; gross weight, 1700 pounds. *-A. K.*

THE MURDER DISEASE

THE germs of typhoid, paratyphoid, typhus, undulant and scarlet fevers, smallpox and diphtheria combined took fewer lives in this country in 1935 than did homicide.

Buying off the Drawing Board

THERE are many commuters by air from Long Island estates to the foot of Wall Street on the East River. When some of these modern commuters grew dissatisfied with their flying equipment, they saw nothing on the market which would meet their needs. So they turned to Grumman Aircraft whose reputation in building amphibians and other craft for the Navy is deservedly very high. L. R. Grumman, president, and "Bill" Schwendler, chief engineer, soon laid out the preliminary drawings of a twin-engined amphibian which was just what these wealthy and sportsmanlike Long Islanders wanted. From these few drawings, they immediately received an order for four of these large and expensive machines; then an order for six more. Hence the title of this note.

The "buyers off the drawing board" were not in the least disappointed, because the Grumman G-21 Amphibian has met all its tests with perfect satisfaction. The ship, equipped with two Pratt & Whitney Wasps of 400 horsepower each, will have a gross weight of 7500 pounds, with a useful load of 2180 pounds, providing for a pilot, co-pilot, four or five passengers, and 220 gallons of gasoline. The equipment is of the most complete and luxurious type, with reclinable chairs, a full-length davenport, ample baggage space, toilet facilities, soundproofing, lighting, and a splendidly laid out pilot's compartment. In fact, the G-21 offers everything that is to be found in an airliner of the latest type. In aerodynamics, structural design, stability, control, and performance the flying yacht also takes the highest rank. Thus, top speed at 5000-feet altitude is 205 miles per hour; the service ceiling is 24,000 feet; take-off run at sea-level is only 796 feet and requires but 11 seconds; landing speed with flaps down is 60 miles per hour; and flight on one engine is readily accomplished.

Entrance is on the right side of the cabin immediately behind the pilot's compartment, with an emergency hatch on the other side. The retractable landing gear is of the well-known Grumman design which is remarkable for its simplicity and complete reliability. The all-metal structure is on lines which have again and again proved acceptable to the critical Navy Department, and the sides and bottom of the hull are so strongly designed that the keel girder is dispensed with.

There are many luxurious seaplane or flying boat hangars on Long Island now in use, with splendid accommodations for the aircraft, fine beaching facilities, cranes to lift the boats out of the water if necessary, and everything that the heart of an air yachtsman can desire. Perhaps the day is coming when it will no longer be fashionable just to own an ocean-going yacht. It will be more "chic" to own a flying yacht! —*A. K.*

The Sport of Amateur Bombing

CREDITED with having started the Tennessee evolution trial some 12 years ago, the latest idea of George W. Rappleya, of Wheeler Shipyard, while of lesser national importance is more amusing. Mr. Rappleya organized a mock bombing contest between a number of private airplanes and a number of small cabin cruisers in the waters of Long Island Sound. The cabin cruisers were armed with cameras whereby "direct" hits on the airplanes could be registered; the airplane pilots were armed each with a dozen one-pound flour bags, which represented the bombs to be hurled on the doughty vessels below. The official score was five to three in favor of the airplane pilots. The fliers struck five of the competing motorboat cruisers with their one-pound flour sacks. The yachtsmen brought down three planes with their "anti-aircraft" camera guns. The new sport proved tremendously exciting, there were no collisions in the air or on the water, nothing was proved, and everyone had lots of fun.—*A. K.*

***Above:* A camera "gunner" makes a direct hit on a plane. Note cross indicating accuracy. *Left:* An aerial "bomb" containing flour theoretically put this boat out of action**

The New Civil Air Regulations

AUTOMOBILISTS often complain of the complexity of traffic regulations, of misleading signs, of rules that change with every city or town or even village. We wonder how they would like to use the new Civil Air Regulations which contain such delightful notes as the following: "60.105. Green Zone of Intersection. A green zone of intersection is a zone of intersection on a green airway in which through traffic on a green airway continues through such zone at a constant altitude, and in which zone traffic on the intersected amber or red airway shall proceed as outlined in CAR 60.58310 and 60.58320." Opinion differs. Some people think that in their new Air Regulations the Department of Commerce has done a splendid job likely to promote safety greatly, and in particular to ensure freedom from collision in the air. Others say that this new piece of bureaucratic regulation will most certainly promote the safety of private flying by making private flying impossible!

That the new regulations are complex is demonstrated by the fact that *American Aviation* has issued a simplifying booklet which has attained immense popularity in the space of a few weeks. The rules of the Air Commerce Bureau have been reduced to English as we know it, and clever illustrating diagrams have been produced.—*A. K.*

Why not Fly Above the Mountain Tops?

THE recent crash of an airliner into a mountain at some 10,000 feet altitude has led laymen to ask: "Why, when flying near mountain ranges, do not pilots fly higher than any peak." Here is an intelligent question to which the answer appears to be: "They should.".

But Dean Smith, veteran pilot of a transcontinental airline, puts the matter in a different light. Let us quote him: "The layman immediately asks, in particular about crashes such as the last one, why the pilot does not fly at an altitude that will clear all the mountains? The answer is that he does when he can, but there are times when to do so is more dangerous than to fly lower. All that goes up must come down and as the airports are lower than the tops of the mountains he must know his exact position when he does descend. There are times when flying higher

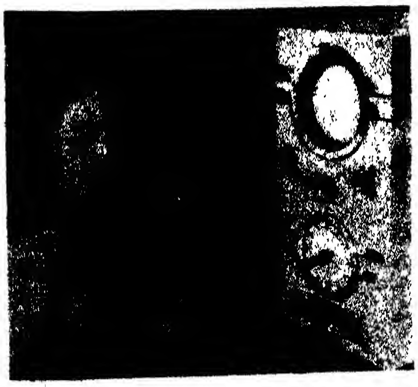
than all mountains means a sure loss of position, when snow-static, ice, and so on, affect him at that altitude but not at a lower one, places where swinging beams and lack of cross checks mean a greater hazard in flying high with the aid of instruments than flying lower in visual contact with the ground. In these areas pilots by necessity grow to depend on their individual skill and judgment as they lack exact means of navigation. Under such circumstances it is impossible to expect all the pilots to have infallible judgment at all times." And sometimes when the pilot has, with apparent justification, lowered his altitude, a crash may result.—*A. K.*

See Your Pitch

PITCH is no longer dependent on a musical ear; a new electronic device permits one to *see* the pitch of any note, whether sung or played, as well as its timbre and volume. And since the eye is a far more critical judge than the ear, it becomes possible for anyone to pitch either voice or musical instrument to a degree of accuracy quite unheard of by former methods.

The resonoscope, as the new device is known, a development of the Allen B. DuMont Laboratories, is simple to operate. Also, it is self-contained and portable, operating from the nearest electric socket or outlet. To use it, one merely turns on the current, places the main dial to the desired note of the scale, and flips a switch. The bullet-shaped microphone now serves as a loud-speaker, emitting the pure note called for. By means of this note or tone, singer or musician can proceed to pitch the voice or instrument. Meanwhile, the uniform wave form of the note appears on the cathode-ray screen just above the main dial.

So far, so good. We have a pure tone or note. We have an image of that tone or note. It now becomes possible to check our pitch by visual means. For this purpose, a switch is thrown to convert the microphone from its loud-speaker rôle to that of a true microphone. It now picks up the sung or played note. The cathode-ray screen instantly reproduces that note in visual terms, so that it may be compared with the pure tone produced by the master tuning fork within the resonoscope. If the note is sharp, its wave form slips off to the right; if flat, to the left. The rate of movement in either direction indicates the degree of sharpness or flatness respectively. If the wave form remains practically stationary, the pitch closely matches that of the master tuning fork. Meanwhile, the smoothness of the wave form indicates the quality or timbre of the note. The more jags and irregularities, the more overtones are present.



The resonoscope combines a set of 12 master tuning forks, electrically actuated, with microphone, amplifier, loud-speaker, and cathode-ray tube. The tuning forks are mounted on a wheel which is rotated by the main dial knob, so that any fork corresponding to the desired note can be brought in position between the electromagnets.

Recently introduced, this device is already being used in broadcasting studios, by some of the musical instrument manufacturers, and by schools for voice training.

Fat from Coal

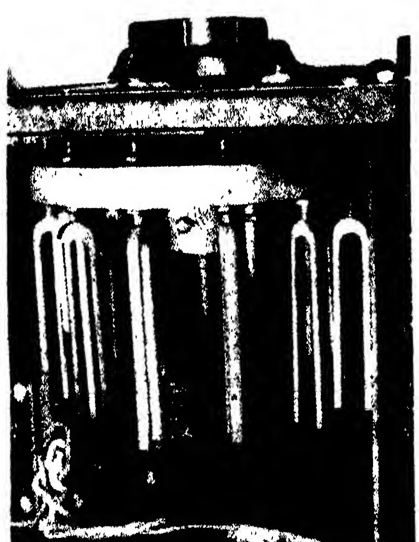
IN Germany's search for substitutes for materials of food value the latest development is a soap made from a fat produced from German coal. The product, said to be quite satisfactory as a cleaning agent, is more expensive yet than soap from fats, but lower prices are expected to be realized through increased production. Fortunately the United States has plenty of fats to make its soap.—*D. H. K.*

Poison Hazard in Spraying Fruits and Vegetables

"POISON—Do not eat." It may be that such a label should apply to ordinarily harmless cabbage if producers use lead arsenate or other arsenical sprays to kill the insects that attack that vegetable during growth.

The hazard from sprayed farm products is unfortunately not limited to the eating of spray left on vegetables. Water supplies, cattle feed, and the soil itself are contaminated. Vegetation grown on the contaminated soil gradually takes up the poisons. In some regions, stock raisers have been forced to go out of business.

In an editorial, the *Journal of the American Medical Association* says: "One valley



Left: **A singer testing the pitch of her voice by watching the wave form on the cathode-ray tube screen.** ***Above:*** **The tuning forks and driving solenoids in the resonoscope**

in the Pacific Northwest has received as much as 7,000,000 pounds annually of lead arsenate for the past 20 years. Therefore perhaps 50,000 tons of lead arsenate have permanently contaminated the soil. Some assume that the spray residue is washed away by rains or is blown away by winds, but the evidence available at the present time indicates that this is not the case."

Here are three rules that the physicians feel should be enforced legally on the producer, pending the elimination of all poisonous sprays:

1. Remove spray residues as completely as possible from apples and other such fruits, preferably by hydrochloric acid rinse.
2. Do not use skins of sprayed fruits in making cider, vinegar, jelly, or other products.
3. Never use lead arsenate or other arsenical sprays on vegetables such as cabbage, cauliflower, Brussels sprouts, broccoli, spinach, kale, celery, and snap beans that are eaten whole.

The housewife, in addition, is urged to wash thoroughly all fruits and vegetables that may have been sprayed.—*Science Service.*

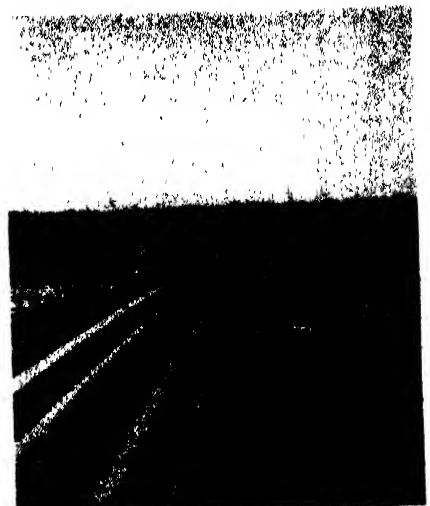
Latest Train Directing System

A NOVEL train directing system was recently installed on the New York Central Lines West at Girard Junction, 17 miles west of Erie, Pennsylvania. This system now simplifies train directing at this busy junction through which pass over 100 trains per day.

Movements through a junction or terminal are made by trains traveling over clearly defined "routes." When an operator lines up a route, he usually thinks of it as having an "entrance" and an "exit." This basic concept of route entrance and route exit is closely related to the means the operator uses for lining up routes, such means being "entrance knobs" and "exit buttons," explained below. The system is called "NX Route Interlocking," from the first syllables of "en-trance ex-it."

In the control room of Girard Junction tower, a small desk-type control machine is used to control the entire interlocking plant.

The train-directing control board



A track layout through which trains are directed by the system described

On this machine is a control board which looks like a map or diagram of the entire track layout. The tracks are represented as white lines on the black panel—the switches and crossovers by indicators which are moved to the desired positions.

At each entrance of every possible route through the plant is an entrance knob which turns clockwise or counter-clockwise, 90 degrees from a neutral or normal position. A small white dot, which turns with the knob, indicates the position of the knob. The arrow in the knob remains stationary, pointing out the direction in which the train is to enter the route.

At each exit of every possible route through the plant is an exit button. It is the usual spring-return type of push-button. The arrow etched on its surface indicates the direction in which the train is to leave the route.

Small indicator lights, inserted at intervals in the white track lines, are illuminated whenever a train is occupying the track. Above the track diagram and in about the center of the control board is a group of "test keys," so called because they are used only when the switches need to be moved one at a time for individual testing.

When a train is approaching the junction, an approach indicator light is illuminated on the track diagram. The operator telephones the dispatcher, who informs him where to direct the train. Upon receiving this information, the operator turns the entrance knob corresponding with the point where the train will enter the plant. He next pushes the exit button corresponding with the point where the train will leave.

Within a few seconds, the route lines up in the field (the switches operating into positions called for by the route) and the signal clears. On the control board, the movable route indicators snap into position called for by the route, thus producing a vivid picture of the route lined up. A light in the entrance knob appears when the signal clears in the field.

As the train passes the signal, the light in the signal changes to red, and the light in the entrance knob is extinguished. The successive illumination of the track occupancy lights indicates the movement of the train through the plant. These are extinguished as the rear of the train leaves the various sections of the route.

The system has been enthusiastically re-

The steel skeleton of the titanic incandescent light bulb memorial

ceived by railroad officials in the United States and abroad, and promises to do much towards simplifying train directing in the future. A large and complicated terminal layout can now be handled with comparative ease and speed, thereby giving the operator more time for his regular duties such as recording trains, receiving and transmitting calls, issuing train orders and other important messages.

This system is to be installed at both ends of the San Francisco-Oakland Bay Bridge to handle the train-a-minute schedule over the bridge. It was chosen because of its simplicity and flexibility of operation.

Lubricating Resin Bearings

SYNTHETIC resins are coming into wide use abroad as bearings for machine parts to replace brass and other bearing metals. Because of their very different characteristics, the lubrication of these bearings has become quite a problem. Water is the ordinary lubricant but it has been found that, in many cases, an emulsion of oil in a soap solution must be used to reduce corrosion of the metal part of the bearing and to cool the resin bearing surface. These bearings are most widely used in Germany, but their advantages are being recognized in other countries as well.—*D. H. K.*

14-Foot Light Bulb

A GIANT electric light bulb, 14 feet high, which will glow as a land beacon atop the 100,000-dollar Edison Memorial tower at Menlo Park, New Jersey, was recently completed by the Corning Glass Works. A crew of expert glass-workers took eight months to complete this emblematic diadem for the tower, the job of laying out the model into curved sections consuming the greater part of the elapsed time.

The 150-foot beacon tower will commemorate the invention of the incandescent electric light by Thomas Alva Edison who, in 1879, sent a rough sketch of his idea to Corning, asking that a bulb of glass of definite dimensions be blown. This original glass bulb, enclosing Edison's carbon filament, became the world's first practical electric light. Corning's contribution to the memorial commemorating the event is likewise notable since the 14-foot bulb is the first circular cast job in the glass industry.

In preparing the bulb for shipment, more than 6000 pounds of amber-tinted Pyrex glass were fitted over a steel skeleton fashioned in a Bronx iron works and shipped to Corning. The bulb itself consists of 164 pieces of cast glass in a two-inch diamond pattern and is nine feet, six inches in diameter. The combined bulb and steel skeleton weigh six tons.

When finally set up the giant bulb will be transformed into a gleaming tower at night, casting its rays for miles about the surrounding Jersey countryside. The inside of the bulb will be outfitted with 960 incandescent electric lights with a 24-inch reflector to be utilized as an airplane beacon.

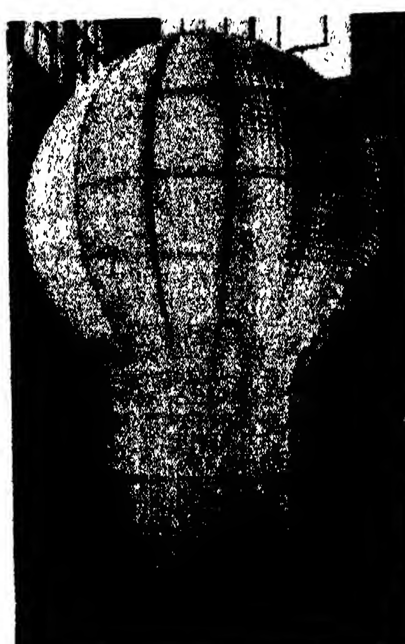
"Air Fed" Fountain

WATER taken from the air flows today in the lobby of the newly air conditioned Cine Riviera in Havana, one of Cuba's leading motion picture theaters.

A fountain in the form of a lion spouts forth water condensed from the air by the new Carrier air-conditioning system recently installed. A line from the drip pan under the dehumidifier on the air-conditioning equipment connects with an outlet on the inside wall of the lobby.

Our Chemical Senses

THE senses of taste and smell, which are used in the detection of flavor, are often called the chemical senses, because they are stimulated directly by the chemical attributes of foods and other substances. The sense of taste is delicate. A single teaspoonful of sugar or of salt is enough for many tastes, and yet some substances are hundreds of times more stimulating to the taste than either of these foodstuffs. Whatever we taste has to be in solution in water, or must dissolve in the saliva, before it can be tasted.



More than three tons of Pyrex were fitted on the bulbous steel framework

Only watery solutions can diffuse through the protective membranes of the taste "buds" on the tongue to act on the special nerves therein. *Sweetness is best tasted near the tip of the tongue, where the sweetness buds are crowded closely together. Saltiness and sourness are best tasted by the front and sides of the tongue, but bitterness only well back,* on the top of the tongue. Bitterness tends to be detected rather slowly, because of the far-back position of the bitter-sensitive nerves.

Most of the interesting flavors we delight in are really not tasted, but are *smelled.* In the moisture and warmth of the mouth, the aroma is released and travels to the smelling area through the back way. This is the part of flavor perception that fails us when we have a cold, which condition interferes with smelling far more than it does with true tasting. Inspectors of foods have long since learned that they can do far more work when they smell rather than taste the article. A baker smells the interior of a loaf of bread to learn about its flavor. A sample of every carload of wheat is smelled to see that it is not musty. Testers of tea, coffee, spices, tobacco, butter, cheese, and liquors depend upon smelling for their first gradings and evaluations. Only for check purposes do they find it necessary to take any into the mouth. The sense of smell is so extremely sensitive that the quantity of material consumed in using it is negligible, and smellings may be repeated frequently.

The reason why smelling is so extraordinarily delicate is that it is done with the "raw" ends of free nerves. Molecules of vaporized materials drawn into the brush of smelling nerves by the operation of sniffing seem to be able to impart sensations to the nerves directly. There have been many theories as to how smelling is done, some involving the need of chemical reaction with the nerve fiber, to produce the odor impression, but now a theory is proposed that the nerves are stimulated by the atomic vibrations within the molecules of the aromatic substance, perhaps by the electromagnetic waves therefrom acting on the electrical system of the nerve ends. It is interesting to speculate a bit while awaiting definite proof that the quivering molecules, through their electrical radiations, are able to impress their vibrations and hence their chemical configuration upon our consciousness. Chemists have long been aware that odor depends upon chemical constitution, but only now has even a feasible theory been found to account for the action.

An interesting party pastime is the "smelling game," in which each participant tries to identify a dozen or so odors in small, dark-colored bottles that bear only numbers and offer no clues as to their contents. In one set, the following substances were used: four perfumes—rose, lilac, jasmin, and violet; four flavors—clove, peppermint, wintergreen, and vanilla; four "drug-store" articles—camphor, carbolic acid, witch-hazel, and tincture rhubarb; and three liquors—Scotch and rye whiskies, and gin. Most people were able to identify outright only four or five of the fifteen. The list of identified odors from such a range of subjects comes close to being an experience rating for the person; naturally good observers and those of wide interests in life make the best scores. Housewives often score well in this test.

The smelling game shows that most people are really very sensitive to odors, but that their associative powers are weak. It is the same type of weakness as the connecting of names with faces or voices. Once a person recognizes an odor, or is helped to recognition by a name or a color, he can do well in noting details of quality. *Most people do appreciate flavor, in spite of their usually poor* showing in its identification, or, even more poorly, in its description.—*Industrial Bulletin* of Arthur D. Little, Inc.

Chemicals Useless to Improve Coal Burning

CHEMICALS added to coal to make coal burn better have little effect on the combustion of fuel, the United States Bureau of Mines has learned through exhaustive tests, reports *Science Service.*

Spurred by continual inquiries about alleged "fuel savers," the Bureau investigated, both alone and in mixtures, all the chemicals known to have been marketed for this purpose, and many others, including water and chlorine. None, it was stated, was found to produce the effects claimed.

Results of the experiments are contained in a bulletin by members of the bureau's staff, and published by the Government Printing Office.

Six-Day Rider's Muscle Power—75 Cents

PEDALING a bicycle for six days appears a most gruelling test of muscle power, yet a single rider if he were able to keep going night and day without a stop would exert but 20 horsepower-hours of energy, equivalent to the energy which 75 cents worth of electricity would buy. This was revealed when some of the racers at Madison Square Garden, New York, tested their strength on a special bicycle, built by General Electric engineers, which accurately measures the muscle power of the rider.

Lake Mead, Largest Man-Made

IN the desert of the southwest, a new and major lake is forming, Lake Mead, created by Boulder Dam. Named for the late Dr. Elwood Mead, Commissioner of Reclamation during the period of construction of Boulder Dam in Black Canyon of the Colorado River, Lake Mead is by far the largest man-made body of water in the world.

It extends up the Colorado River 101 miles at this time (autumn, 1937) and eventually will reach a maximum length of 115 miles. It will be eight miles wide at the widest point and, when filled, will have a maximum depth at the dam of 589 feet.

Lake Mead will store 30,500,000 acre-feet of water, sufficient when expressed in terms of gallons to supply 5000 gallons for each and every person on earth. Today it is slightly more than half filled. It now has a depth of about 460 feet and covers more than 91,000 acres.

Prior to 1935, there were few localities in the world more forbidding or more difficult of access than the bed of what now is Lake Mead. In the midst of a desert and desert mountains, the Colorado River

then flowed through this area principally at the bottom of tremendous canyons. Only a few parties of daring explorers had ever traversed the length of the future Lake Mead, and many of the side or branch canyons, now coves in the lake, were unexplored.

When the diversion channels were closed at Boulder Dam February 1, 1935, Lake Mead immediately began to form. One year later, it held 3,000,000 acre-feet of water. Two years later, it contained 9,000,000 and was extending far up the river, through the sheer-walled Boulder Canyon, through Virgin, Iceberg, and Travertine Canyons and was beginning to reach into the lower and unvisited end of the Grand Canyon itself. It can safely be navigated now over this entire reach of river.

The Colorado River was a fluctuating stream. It still is variable above Lake Mead, although Boulder Dam has made it a reliable, perennial watercourse downstream. When the snows of the mountains at its headwater melt in the spring, great floods move down the Colorado. After they have passed, the flow drops erratically to little more than a creek. The floods do not pass Boulder Dam, but are caught and stored to fill in the valleys of the flow in the summer and fall to protect the water users downstream.

As a result of these periodic floods, Lake Mead grows by fits and starts. It rises rapidly from March to July, but will decrease in size between August and February. During three or four months, the inflow into Lake Mead is greatly in excess of the outflow through Boulder Dam. But during the remainder of the year, the inflow and outflow are about equal or the outflow exceeds the inflow.

During 1936, 5,634,425 acre-feet of water were allowed to pass Boulder Dam. In the future and until the states of the upper Colorado River basin are prepared to use the water allotted to them, this diversion may increase to the normal flow of the river, or about 15,000,000 acre-feet a year. The amount of water diverted through the dam, of course, has a definite bearing on the speed with which Lake Mead fills. Another factor is the total amount of run-off in the river above the dam. This varies with the rain and snowfall over the watershed. If normal conditions prevail, Lake Mead may be filled in three years.

Paper from Black Gum

IN the development of Southern woods for paper making, the black gum tree has been found to yield a high-grade printing paper. Its usefulness for this purpose has been investigated as a supplement to the fast growing pines of the Southern coastal plain. Black gum is so plentiful that it is estimated to add as much as 40 percent to the wood pulp resources of the South. —*D. H. K.*

Mankind May Strive to Save Insects

BEFORE New Year's Day of the year 2000, man may very possibly reverse his present militant drive against insects, and actually strive to save many of the species he is now indiscriminately destroying with a grim determination.

This picture of the future, quite the opposite of the conventional present concept of inevitable, implacable war to the death between man and the insects, was presented before a gathering of members of the American Association for the Advancement of Science by Dr. Edith M. Patch of the University of Maine, president of the Entomological Society of America.

This swing of the pendulum, in the relations of mankind to insects, may be expected as the result of present strenuous efforts to meet an immediate emergency. There is no question but that at least a few species of insects are so dangerous to man that they merit all the serious hostility he bestows on them. Nor is the analogy of war much overdone, when it comes to man's efforts against insects, for in this strife man employs almost as much ingenuity as he does in his military efforts to destroy his fellow-man. Poison sprays, dusts, fumes, gases, flame, scalding steam, plowed trenches, tars and other sticky traps, luring lights, X rays, electrocution, ingenious espionage, alliances that turn insect against insect—all these tricks and more are in man's armamentarium against the opposing six-legged hosts.

But a dilemma arises through the very efficiency of modern methods of insect destruction, particularly such wholesale barrage effects as the use of airplanes for laying down of poison dusts by the square mile, over forests, cotton plantations, and mosquito-breeding marshes. These wide swathes of death sweep down not only the few insect species that are man's enemies but also the many that are his friends, or at most merely neutral and harmless.

Complaints of beekeepers are already loud in the land. But honeybees are only one species; there are many other wild kinds, like bumblebees, carpenter-bees, and others that are of equal value with honeybees as pollenizers of orchards, garden plants, and ornamental shrubs and flowers. These also are poisoned, but they die unnoticed except by professional entomologists. It may be necessary some day to set aside insect refuges, where spraying and dusting will be prohibited, to insure the transfer of pollen among the flowers we value for beauty or use, Dr. Patch suggested.

Birds, too, need insects for food, at least when they are young. It may also be necessary to insure that the trees and brushlands of their refuges shall be left in a nourishingly "buggy" state, for the sake of the hungry nestlings. And though it may sound a bit fantastic now, it is even conceivable that as present-day America has big-game sanctuaries for the benefit of the students of nature, future nature students may have to resort to "little-game" sanctuaries when they crave to swing a collecting net in the air, or grub in the ground for grubs.—Copyright, *Science Service.*

Radio on Pitcairn Isle

A COLORFUL throw-back to the days of the history-making mutiny of the British frigate *Bounty* is to be found in the life of the natives of lonely, mid-Pacific Pitcairn Island, which is inhabited by the descendants of Fletcher Christian, his band of mutineers, and their Polynesian wives.

PITC, the island's only radio station, is in charge of Andrew Young, chief operator, and a group of assistants, all of whom are self taught in Morse code and radio tech-

nique. Alan Eurich, writing in a recent issue of *QST*, recounts that even the children of Adamstown, the only village on the isle, are proficient Morse experts, sending messages to each other in the code with whistles.

Young's amateur radio station has been in operation since the early 1920's, and previous to its present modernization operated with one storage battery, which had to be sent to New Zealand to be recharged when its power ran low. Now, however, a number of radio manufacturers, including RCA, are coming to the rescue by providing sufficient parts to permit the building of a complete new radio communications system.

Leadleaf Paint

METALLIC LEAD is making its *début* as the main ingredient of a protective paint, says the *Industrial Bulletin* of Arthur D. Little, Inc. Traditionally, lead has been used in oxide forms as a chief pigmentary component of many common industrial and marine paints. "Metalead" paint, however, is made from thin lead foil broken up to fine flakes. When spread out upon a surface in the form of a paint film, the individual tiny flakes of lead form a "leaf" or interleave into a film.

The adhesion and ductility of the leadleaf paint film are dependent on both lead and the vehicle; at present the vehicles employed are the new synthetic resins and Chinawood oil (tung oil) and mixtures containing phenolics such as Beckacite, Durez, or Bakelite. Linseed oil has not proved satisfactory.

The new paint is offered chiefly as an undercoater or primer on structural frame work and general construction and may also find eventual use in the chemical, oil, and transportation industries. Other uses are indicated by its unusual properties of resistance to high temperatures up to 500 degrees, Fahrenheit, and its chemical resistance to the fumes of common acids and to noxious industrial vapors, such as those of hydrogen sulphide. Its adhesion is illustrated by its application to galvanized iron, on which it may be applied directly without special pre-treatment of the metal surface. As offered to manufacturers, the lead is in paste form with only 10 percent vehicle and weighs about 40 pounds to the gallon. In this condition it is almost as bright as aluminum paint, but in the painted film, after drying, it dulls to a dark gray.

Metalead paint is being groomed chiefly as a competitor to red lead wherever the latter is used. At eight pounds per gallon it may thus have advantage in price over red lead, which may run to 25 pounds per gallon. It cannot compete with aluminum in cost, although greater film flexibility is claimed. Exposure tests reported as carried out near Great Salt Lake have shown excellent resistance and adhesion.

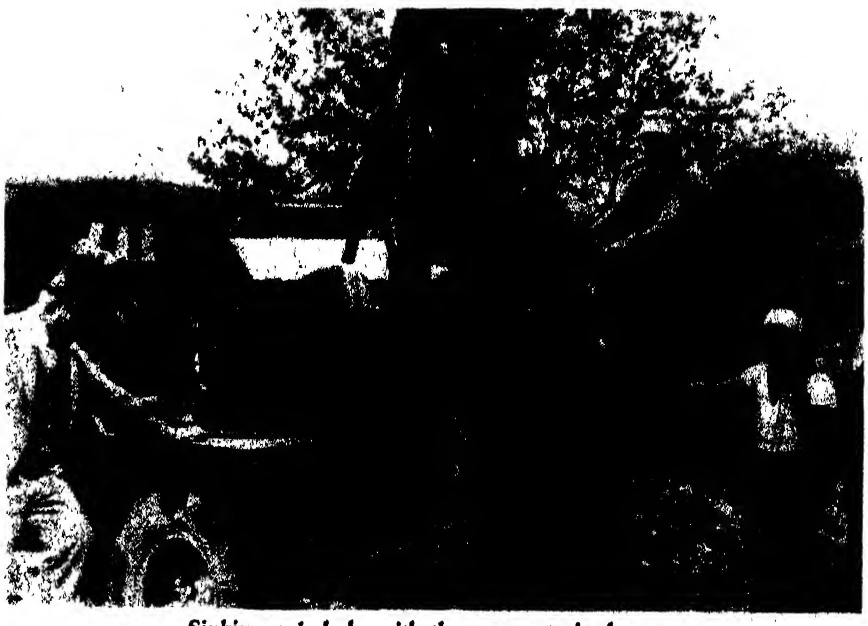
Metalead paint is claimed as suitable for waterproofing or sealing concrete, which then becomes more resistant to mild acids and alkalies, oils and greases, and salt brine solutions. Similarly, wood may be coated, as the paint metallizes the outside cellular structure.

A paint manufacturer on the Pacific Coast has reported the successful adoption of this paint in special locations. Developments are understood to be under way in the laboratories of some of the large paint companies where experiments on vehicles for this paint specially adapted to particular uses in industry and in construction are being carried on.

Motorized Pole-Hole Augur

TWO new earth-boring machines, delivered recently to an eastern railroad, are making impressive dents in the railroad's right-of-way. Designed for heavy-duty work in the railroad's construction program, the trucks are FWD vehicles, manufactured by the Four Wheel Drive Auto Company. They enter the railroad right-of-way from the highway, and dig 14-foot holes for transmission towers which will carry power lines.

The construction of the trucks enables them to go almost anywhere off the right-of-way. With drive to all four wheels, the trucks can negotiate steep grades and deep cuts with ease. Their maneuverability is increased by power steering. This mechanism gets its hydraulic power from a power take-off on the transmission which operates a pump furnishing the pressure required.



Sinking pole holes with the new motorized augur

A close-up of the augur blades

Dual tires, front and rear, enable the vehicles to work directly on the right-of-way. Up or down the steep grades, and within the steep cuts, the trucks can operate in very low gear, provided by a special two-speed clutch.

With a tower 18 feet high, and an augur shaft 20 feet long, the machines are the largest of their kind ever built. Furnished with both 30-inch and 36-inch augurs, the machines can dig 14-foot holes within a fraction of the time usually required by manual labor.

The huge digging tower is raised by two large coil springs of the anti-gravity type. This type of spring cuts tower-raising time to a minimum, and helps assume the weight of the tower in the raising operation.

The boring machine mechanism is mounted on a turntable, so that the operator may dig holes on either side of the truck, or behind it.

From Where, Hither?

One of the two pieces of the largest meteorite ever seen hitting the earth has just been added to the meteorite collection of the Smithsonian Institution. This "shooting star" exploded in the air near the town of Paragould, Arkansas, at 4 A.M., February 17, 1930. It is believed to have broken into three pieces, two of which were recovered. The largest, weighing approximately 300 pounds, is now in the Field Museum in Chicago. The second, 70 pounds in weight, comes as a gift to the Smithsonian from Stewart Perry, Michigan publisher and meteorite collector. The third, which may have been the largest, has never been found.

Not only was this the largest meteorite of any kind ever seen to hit the earth, but it is the largest stony meteorite of which there is any record. Some of the iron meteorites are very much larger, one in South Africa weighing approximately 60 tons. Most stony meteorites, which probably constitute the bulk of shooting stars, are very small when they strike the earth's surface, and the great majority of them are entirely consumed in the upper atmosphere, fortunately for mankind.

This particular fragment is of singular mineralogical interest and will be subjected to intensive analysis. It seems to be a fusion of two distinct bodies, as if they had crashed together and the smaller was driven into the larger by the force of the impact. Such a collision might have taken place in their flight through space or it might have occurred in the original cosmic catastrophe, perhaps the breaking up of a planet in the distant past, which may be responsible for all meteorites.

Rubber "Lung"

When infantile paralysis has paralyzed the muscles of a patient's chest and abdomen, he must lie enclosed in that cumbersome chamber which has come to be known as an "iron lung." Because his chest muscles are useless, the rhythmic application of a partial vacuum to the outside of his body is necessary to expand and contract his lungs at regular intervals. This the "iron lung" does, for the whole body is enclosed while the head is outside. A patient might lie in this contrivance for months stretched out and inert, lacking massage and necessary treatment of body tissues except that which can be administered by several nurses working at great disadvantage through small holes in the walls of the "lung."

Dennis R. Scanlan, respirator expert and member of a famous surgical instrument firm in Stockholm, Sweden, had been studying this problem for months since young Fred Snite, Jr., was returned from China in an "iron lung" some months ago. Mr. Scanlon had definite ideas regarding a new type of artificial lung and accordingly he took his problem up with officials of the General Tire Company. With the assistance of research engineer Herman Kraft and others, there was evolved an apparatus which has been called a "rubber lung." It is much smaller and lighter than former metal "lungs" and, instead of enclosing the entire body of the patient in the respirator, it encloses only the patient's thorax and abdomen, leaving all four limbs and the perineal region free for nursing care. It has been called the Stille-Scanlan respirator.

Smaller, lighter artificial lung

The Stille-Scanlan respirator consists of a cuirass of aluminum, which is made to fit closely to the upper part of the patient's body by rubber fittings which taper in hardness from hard rubber down to the softest of sponge rubber which lies directly against the patient's body and which seals the partial vacuum which lifts and lowers the helpless chest of the patient. Only the thorax and abdomen are covered by the cuirass, enabling the patient to rest comfortably and to require no more care than any other severely ill person.

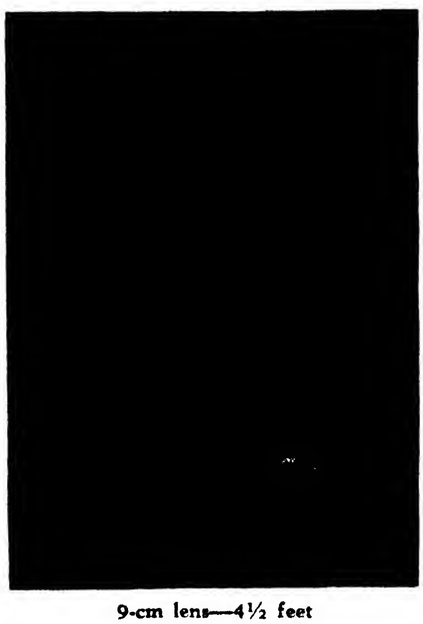
CAMERA ANGLES

Conducted by JACOB DESCHIN

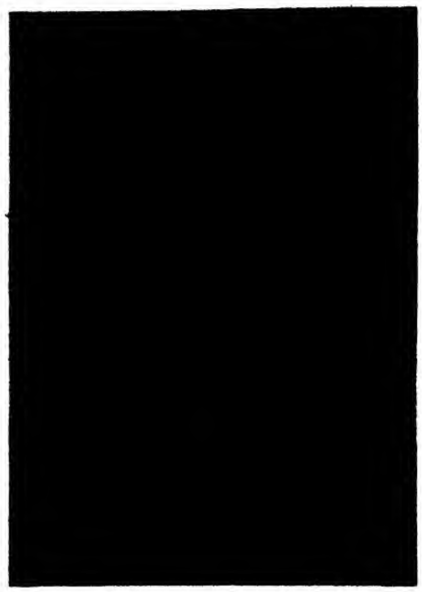
Your Camera Lens

THERE are still a great many camera users who take their camera lens for granted, but the number is growing smaller all the time as the fact is realized that, after all, it is "the glass eye" that makes it possible for "the little black box" to function. This month we will devote a little space to some elementary lens facts, so you fellows who learned it all a long while back may consider yourself duly warned if you prefer to "skip it."

Have you ever examined all the letters, words, and numbers that appear on the front of the lens mount? It is packed full of essential information. The particular lens we are examining at the moment, and this is typical of all lenses, shows the name of the manufacturer of the lens and the location of the factory. This is your guarantee of quality. Following it is a seven-figure number, the so-called "serial number" and the lens' sole identification. This number is highly important. First established at the lens factory, it is recorded every time it changes hands. It furnishes the clue to the age of the lens and its entire manufacturing and commercial history. If the lens is lost or stolen, the serial number is the means by which it is traced. The owner of a camera will do well to make a note of the serial number of both the camera and the lens and keep these numbers among his valuable records "just in case."

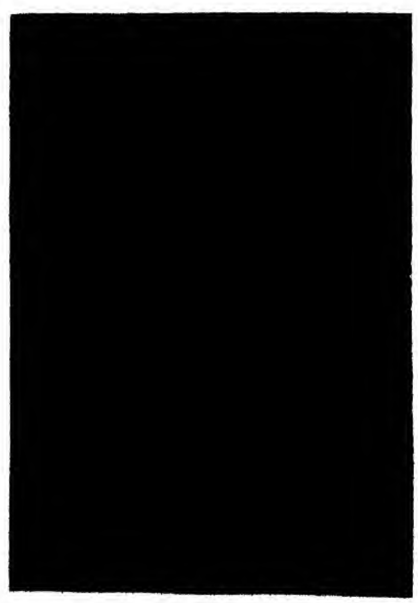


9-cm lens—4½ feet



15-cm lens—4½ feet

The next piece of information we read as we make the circular tour of the lens mount is the name of the lens. This, like the manufacturer's name, has also come to be a guarantee of quality and certain characteristics. Thus, one lens will be known for the sharp negatives it produces, another for its portrait quality; that is, a tendency to give a slight softness to the image. Next, we come upon a curious thing and one that bothers many novices. We read, "1:3.5." What this actually means is that the diameter of the lens measures 1/3.5 of the focal length of the lens (which we will take up soon).



27-cm lens—4½ feet

Just Turn the Page to See the

WINNERS

in the Second Scientific American

PHOTOGRAPHY CONTEST

Thus, if the focal length is three inches, the diameter of the lens measures a little less than one inch. This is the lens "speed" you hear about. The greater the diameter of a lens of a specific focal length, the "faster" it is said to be, which means that the larger the glass the more light is permitted to enter the camera at the full opening of the lens. This may, perhaps, explain the "Big Berthas" you see on some miniature cameras. They look very imposing and some prefer them for this reason, even though they are quite expensive, but many fellows who buy a camera equipped with an F:2 lens, for example, may never use a lens opening wider than F:2.8. Yet they will pay 100 dollars more for the faster lens just because of a vague notion that they may some day, some time, find a use for it. Actually, we suspect that in many cases it is a matter of sheer camera vanity. And think of the added weight!

Incidentally, the relative speed of one lens as against another may easily be determined by squaring the diameter of each of the lenses being compared and dividing one by the other. Thus, 2.8 multiplied by itself comes to 7.84, and the square of 2 being 4, the F:2 lens has practically twice the speed of the F:2.8.

One more piece of information the lens mount affords is the focal length of the lens. This reads "/-7.5cm." The cm stands for centimeters, the figure being equal to 3 inches. The symbol *f* stands for focal length. It is generally agreed that the proper focal length of a lens is the diagonal of the negative size it is used to cover. Thus, a 3-inch lens is generally employed in cameras delivering 1⅝ by 2¼ or 2¼ by 2¼ negatives; a 4-inch lens is used for the 2¼ by 3¼ camera and a 2-inch lens for the 35mm camera.

In addition, where the lens mount of the camera will permit interchangeability of lenses, one may use as extra lenses, objectives (the highfalutin term for lens) having a shorter or longer focal length than that of the normal lens used for average subjects. The shorter lens is called the "wide angle" lens because, from the same distance, it covers a greater area than the normal lens, and the longer lens is called the "telephoto" because, still from the same distance, it cuts down the angle of view and therefore covers less area, producing a larger image on the negative.

The illustrations show a comparative study of the effect of using the three different types of lenses while photographing bayberries all from the same distance, namely, 4½ feet. A fourth illustration is included to show the close-up effect that may be obtained by using the wide angle lens and a very long camera extension. In order to get this particular close-up, the lens was placed 4½ inches from the subject. The reader will

Wide-angle lens—4½ inches

undoubtedly notice the admirable selective effect resulting from the employment of a telephoto lens.

In some future issue we hope to have more advanced dope on the subject of lenses.

The Contest is Over

FROM stack after stack of photographs varying in size from 3¼ by 4¼ up to 16 by 20, the judges of the Second Scientific American Photography Contest finally, by a process of elimination, selected the prize-winning prints and those that were awarded honorable mention. Over 1000 entries were received for the contest, coming from all over the world; judging was no easy job, in view of the fact that so many of the photographs were of excellent quality. We feel, however, that the judges deserve unstinted praise for the results of their labor, and that those who did not win prizes can console themselves by the fact that they were up against possibly the stiffest competition that could be found in any contest for amateur photographers.

The Board of Judges consisted of Robert Yarnell Richie and Ivan Dmitri, well-known commercial photographic artists, and Karl A. Barlaben, F.R.P.S., Dean of the New York Institute of Photography and noted writer on photographic subjects.

The prize-winning photographs are reproduced and described on the following pages. Those photographers who were accorded honorable mention are as follows:

L. A. Geddes, New York City
C. Haeberle, Elmhurst, Long Island, New York
Stephen Harris, Dover, Massachusetts
Clarence B. Lober, Fort Lewis, Washington
Harrison N. Mucher, Reading, Pennsylvania
Dan Napoli, New York City
G. L. Osmanson, Morris, Illinois
Arthur J. Samal, Haddonfield, New Jersey
William H. Siebrecht, III, Great Neck, Long Island, New York
L. A. Styles, San Francisco, California
Peter Jean Vest, New York City

Inasmuch as there was such a large number of other excellent photographs sub-

(*Please turn to page* 116)

FIRST PRIZE

By
FRANK FISHER, Jr.

First prize of 75 dollars in the Second Scientific American Photography Contest was awarded for this print submitted by Frank Fisher, Jr., 11431 Colfax Street, Hollis, L. I., N. Y. It was taken with a Contax camera on Eastman Super-X film

SECOND PRIZE

By CARLYLE F. TREVELYAN

Second prize of 50 dollars went to Carlyle F. Trevelyan, 161-19 59th Avenue, Flushing, L. I., N. Y., for the print reproduced above. Taken on Agfa SS Pan film with a Voigtlander Avus camera

THIRD PRIZE

By Z. D. BARNI

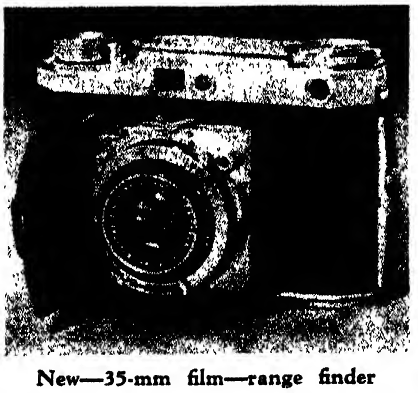
This interesting portrait study received third prize of 25 dollars. It was taken by Z. D. Barni, Ghulam Hasan Street, Lahore, India, on Panatomic film with a vest-pocket Kodak

(*Continued from page* 113)
mitted, it is not possible to list here those whose prints survived through a large part of the judging. We can only express our sincere thanks to all those amateur photographers who made our competition such a success. We hope that every one of them will be represented in our next contest, for which plans are now being made and which will be announced in a future issue. Watch for the rules. *They are being drawn so that there will be a larger number of prizes, there will be various divisions in which prints may be entered, and there will be more chance of winning.*

Kodak Retina II

A NEW 35-mm miniature camera, the Kodak Retina II, similar in size and styling to the original F:3.5 Kodak Retina I, incorporates a number of technical advances, particularly in lens speed, flexibility of operation and "error-proofing." It offers a choice of high-speed anastigmat lenses, either F:2 or F:2.8; is equipped with coupled range-finder focusing, Compur shutter speeds from 1 full second to 1/500, body shutter release, and double-exposure-prevention device. Lens and shutter are mounted on a focusing helix, moved by means of a large milled knob.

Shutter plunger and film-winding knob are coupled so that once the shutter is tripped, the film must be wound before the shutter



New—35-mm film—range finder

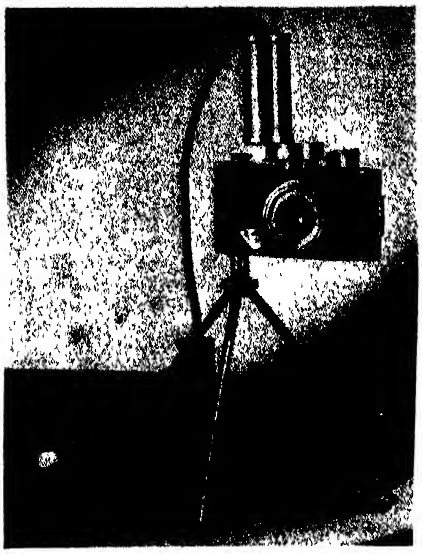
release will operate again. This gives positive protection against double exposures. The film winding knob is halted automatically by a dead-stop device when the proper amount of film for another exposure has been wound into place.

The range finder is of the double-image or coincidence type. As the lens-focusing knob is moved, two images are seen in the range-finder field and when these two images coincide perfectly, the object imaged is automatically in sharp focus.

Remote Control Release

SEQUENCE shooting by remote control, a method particularly suitable for naturalists and others desiring to take candid pictures while remaining unobserved at some distance from the camera, is now made possible with the Robot Remote Control Release. Designed as an accessory for the Robot camera, this helpful device should open the way to new camera adventuring in several fields.

"This new and simple accessory," the distributors, the Intercontinental Marketing



Remote release for Robot

Corporation, announce, "contains a plunger actuated by an electric magnet which activates the release. The operation is controlled by economical flash-light batteries and a push button which are connected to the camera by a wire of any required length. Due to the automatic film transport and automatic shutter release, a feature of the Robot, up to 24 pictures may be remotely shot."

Current Bulletin Briefs

It is probably an idle question, but have you ever investigated the columns of the Current Bulletin Briefs section in the back part of every issue of Scientific American? Brief reviews are contained there on pamphlets and booklets relating to various subjects, including items of particular interest to amateur photographers. Make it a practice to look at this section every month; you'll find it a good habit.

Kent State Photography Contest

A competition in news and pictorial photography is announced by Kent State University of Kent, Ohio, in connection with a Short Course in News Photography to be held at the University March 3, 4 and 5, under the direction of the Department of Journalism. The closing date for the submission of prints to either the news or the pictorial competition is February 5. Prints are preferred in 11 by 14 or 8 by 10 and not smaller than 5 by 7 inches, preferably mounted on 16 by 20 mounts. It is requested that the name of the photographer does not appear on the front of the print; the name and address of the owner, however, should appear on the back of each print, which should also be accompanied by exposure data, including kind of camera, aperture, shutter speed, lights, time and brightness of day, and so on.

The rules of the News Photography Competition are as follows: Eligibility: open to news photographers, workers on newspapers, students and instructors in schools and departments of journalism, correspondents for newspapers; entry fee: 50 cents for the first print entered, 25 cents for each

additional print titles or cutlines: each print must be accompanied by a brief statement of the news situation covered; awards: ten dollars first prize, five dollars second, and five honorable mention awards; judging: by standards that usually determine whether or not a print is a good news picture.

The rules of the Pictorial Photography Competition are: Eligibility: without restriction and as many prints may be submitted as desired; each print must have a title; awards: a purchase prize of 25 dollars (first prize), and 10 dollars second prize, plus five honorable mention awards; entry fee: one dollar, for the first print entered, 50 cents for each additional print; judging: by the usual standards governing the awarding of honors to pictorial photographs—composition, subject matter, approach, photographic excellence, and similar points. Judges of the Pictorial Photography Competition will be Frank R. Fraprie, F.R.P.S., and the staff of *American Photography Magazine.*

Entry blanks may be obtained by writing to Professor A. Clarence Smith, Kent State University, Kent, Ohio.

Sunlight on the Water

SOME folks may think differently, but here is the way we like to photograph sunlight on the water—not the sunlight direct, but sun diffused by a thin cloud curtain. The highlights which here possess a beautifully smooth, soft quality, would be

"Sun and Clouds"

glaring and paper-white under the direct sun. Here the sunlight is spread over a wide area, instead of being limited to a narrow path. The composition is arranged to give prominence to the water, which here is obviously the most striking element of the picture, and the tones and masses of the cloud formations are suitably arranged in the general composition.

Beginners' Dark-Room Outfit

ALL that it takes for a beginner in photography to develop his film and make prints from the resulting negatives is contained in a "rookie" dark-room outfit just announced by Eastman Kodak Company. The complete kit, which is extremely inexpensive and serves for negatives up to and including 3¼ by 5½ inches, contains the following items: Brownie dark-room lamp, model A; a four-ounce graduate; three 4- by 6-inch developing trays; one ½-pound package of Acid Fixing Powder; three tubes of Universal Developer; two dozen sheets

To start you off

of Velvet Velox paper, Contrast No. 3 grade, size 3¼ by 5½; two film clips; a glass stirring rod; printing frame and glass; and an instruction booklet giving complete information for developing and printing negatives. In short, the ABC Darkroom Outfit, as it is called, contains all that it takes to make the first step a success. If the beginner means business, the ABC outfit will whet his appetite for something better and if it does only that it will have completely served its purpose.

The Minicam Market

A STATEMENT of editorial needs has been isued by *Minicam*, the new magazine devoted to miniature camera photography. The magazine's editors invite all comers who have anything to say photography-wise and can illustrate their points with pictures. And "don't worry about literary style," they add, "as the final wording will be worked out at our editorial offices."

The editors invite prospective contributors to submit a brief outline or synopsis before actually writing the article; say they prefer 8 by 10 glossy prints but can use prints that are larger or smaller and ask that "each photograph be accompanied with a detailed description of how it was composed, lighted, posed, exposed, and so on." They suggest that the description include the circumstances and problems involved in the taking and printing processes. The magazine's address is: *Minicam*, 22 East 12th Street, Cincinnati, Ohio.

Pay as You Shoot

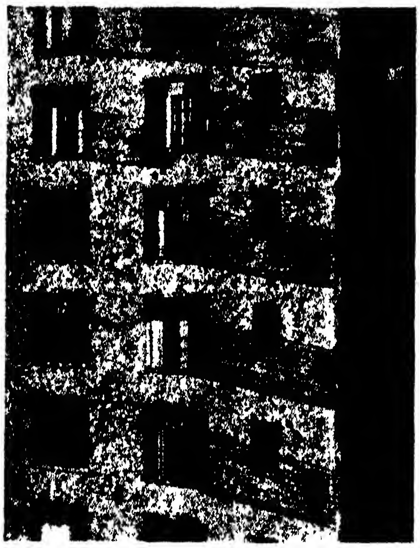
THE time-payment plan idea as applied to the purchase of cameras seems to be making some headway in the United States, following the recent leadership in this connection by E. Leitz, Inc., who with their "Pay for it as you use it" idea have started something that already has brought others into the field. We know that in England the plan has been in vogue for a long time and the fact that the plan seems to be going over in that country has evidently inspired the introduction of the idea here.

It seems no more than fair, when good cameras come as high as they do, that a prospective buyer should be given the same opportunity for paying while using that he has when purchasing a typewriter, a radio, an automobile, or other expensive item. The

idea will prosper, we believe, but there is a danger that the low initial payment may induce many to purchase who have only a vague idea of where they are going to get the balance of the payments as they come due. However, common sense will, in the main, guide enthusiasm and desire. The time-payment plan has many good points to commend it, one of which is that it gives the fellow with little money in his jeans but lots of ideas about how to make some, if he can only get hold of a camera, a chance to get out of the red by making pictures that sell and that, eventually, will more than pay for the camera and the expenses involved in using it.

Rhythmic Patterns

Of course, it was quite accidental that some windows were open and others, fortunately those at the left, were closed when we looked out of our window one Sunday morning. Probably there's nothing specially startling about the picture but it appealed to our camera sense because of the regularity of the shadow patterns, the "feel" of the sunlight on the brick wall, the



"Across the Way"

atmosphere of domesticity in the scene as a whole. Rhythmic shadow patterns are always a delightful subject for the camera and there are few subjects, humdrum though they be, which are not made picture-worthy through the employment of this pleasant device. Patterns of this sort may be created in one's home by artificial light, but perhaps it is more pleasant to meet a "ready-made" subject while strolling in the streets. However achieved, it is an enjoyable photographic exercise.

Film Chest Negative File

A NEGATIVE file having a capacity of 3600 35-mm. negatives or a corresponding number of other size negatives up to 2½ by 4¼ inches has been placed on the market by the Central Camera Company. The file is a metal box measuring 10½ by 6½ by 4⅛ inches and contains 100 envelopes, each holding a folded transparent sheet accommodating six strips of negatives. A humidifier pad and a bottle of humidifying solution come with the file.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

THERE is only one star whose actual image we can see, the sun. What we see of the others is only diffraction patterns none of the surface detail. This follows from physical optics. Because the actual appearance of the stars is forever hidden from us we have much curiosity concerning them, but what we learn about their behavior must be had by indirect methods

Tombaugh and his sun telescope

such as the one Professor Russell explains on another page. Anyone, however, can look at the sun; it is the biggest thing in the sky. That may possibly explain in part why so few of us do look at it. Below we describe Clyde Tombaugh's sun telescope, with its unusual details for sun study.

Most amateurs know the rather romantic story of Clyde Tombaugh, the Kansas farmer's son who, from one of the earliest editions of ATM, made a telescope, then went to Flagstaff, Arizona, and applied for a place at the Lowell Observatory. Something about his enthusiasm must have impressed the Director, for Tombaugh was given a job examining plates in the search for the undiscovered planet which Lowell had predicted years previously, and it wasn't more than a few weeks before he discovered the image of what turned out to be the planet Pluto. Tombaugh thereafter spent part of his time at Lowell and the remainder in college, and is now at Lowell hunting for more planets. While he is now a professional astronomer, the professionals can't entirely have him! At least, we amateurs will keep one hand on his coat-tail. (Incidentally, three former amateur telescope makers are now working as professional opticians: Daniel E. McGuire, ATM, page 380, slit test, who has been with Fecker some months, Lew Lojas, patron saint of the New York telescope makers, who has been with Mogey for some time, and Kieffer of Pittsburgh, now employed in the finishing room of Bausch and Lomb, making flats and prisms.) Here is a part of a letter from Tombaugh.

"The views I have had through my solar telescope the past few months have been marvelous. Since we are in the midst of an extra rich sunspot maximum, a brief description of my instrument may interest some of the amateur telescope makers.

"I made a 12-inch mirror having a focal length of 148½", and left it uncoated for use as a solar telescope. A 1¼" right-angled prism was used for a diagonal, but was mounted in a reverse position—that is, the diagonal face was slanted toward the concave mirror and eyepiece. This allows some 93 percent of the light reaching the diagonal to be transmitted out through the other faces in directions away from the eyepiece. Thus, from the two glass reflections, the light from the sun is reduced to about 1/300 of that falling on the concave mirror. I carefully selected a good pair of neutral-tint drivers' glasses, the darkest I could obtain, from a dime store. The lenses were removed and mounted just in front of the eyepiece (toward the diagonal). Each one probably transmits about 20 percent of the light—perhaps less, as they are quite dark. Therefore, the two together transmit only 1/25th of the incident light. Hence, altogether, the solar light is cut down about 7500 times. Anyway, with the mirror diaphragmed down to 6", and using a magnifying power of 200 diameters, the solar image, or surface of the sun, appears only about one third as bright as a bright cumulus cloud to the naked eye.

"From experience with daytime seeing, I have found that apertures larger than 6" are not practical. Also the steadiest seeing occurs between 8 and 9:30 A.M. I observe the sun about one day in two or three, on the average—picking the better days. On about half of the days the seeing is too unsteady to see the 'rice-grain' structure of the sun's surface. About one morning out of 15 or 20 the definition is really fine—6 on a scale of 0—10. At those times the structure of sun-spots, faculae, and rice-grain background is seen to be intricately delicate and marvelous to behold. On several occasions I have seen white, narrow bridges, filaments and tongues which were less than one second of arc in width, in the umbra of some of the big spots—resembling in appearance the famous drawing of a sunspot by Prof. Langley.

"The long focal length and the 6" diaphragm make my solar telescope an $f/25$. The long focal ratio and small angle permitted me to place the prism diagonal off the axis just enough to clear the 6" beam of light, and next to the eyepiece. I habitually use a power of 200 diameters, and when the seeing is good the details of sunspot structure are very sharp and well defined.

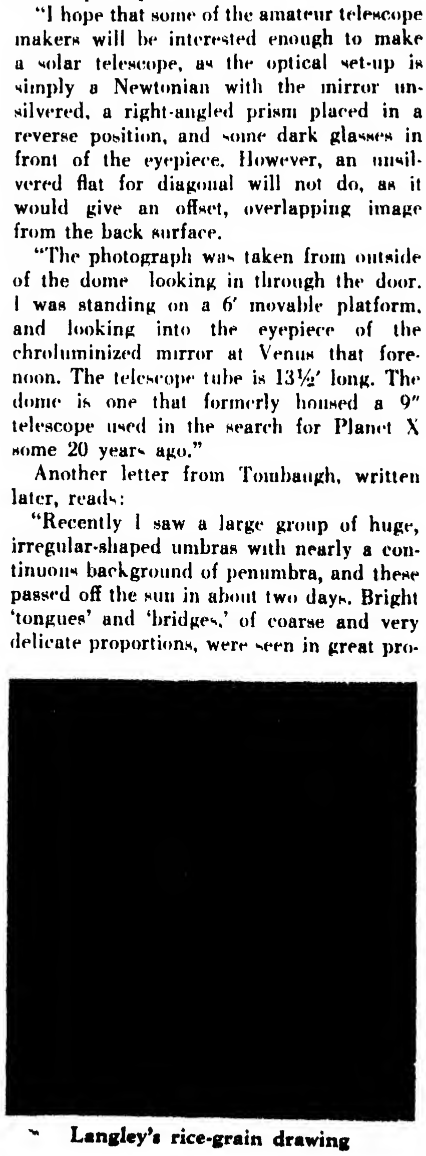
"The heating of the mirror when exposed to the sun evidently does not affect the figure seriously, as I have obtained very fine definition during a period of 20 minutes' continuous exposure to the sun. Possibly the 3" outside zone of the mirror which is shielded by the diaphragm serves to hold the figure from distortion. The 12" mirror was made from polished plate glass, and is only 1⅛" thick. I suppose an 8" mirror, uncoated, diaphragmed down to 5", and having a focal length of 75" or 100", would be a practical combination. Unless the cone of reflected light is very slender, I would not then advise setting the diagonal prism off the principal axis.

"I hope that some of the amateur telescope makers will be interested enough to make a solar telescope, as the optical set-up is simply a Newtonian with the mirror unsilvered, a right-angled prism placed in a reverse position, and some dark glasses in front of the eyepiece. However, an unsilvered flat for diagonal will not do, as it would give an offset, overlapping image from the back surface.

"The photograph was taken from outside of the dome looking in through the door. I was standing on a 6' movable platform, and looking into the eyepiece of the chroluminized mirror at Venus that forenoon. The telescope tube is 13½' long. The dome is one that formerly housed a 9" telescope used in the search for Planet X some 20 years ago."

Another letter from Tombaugh, written later, reads:

"Recently I saw a large group of huge, irregular-shaped umbras with nearly a continuous background of penumbra, and these passed off the sun in about two days. Bright 'tongues' and 'bridges,' of coarse and very delicate proportions, were seen in great profusion. There was also a very large spot attended by a host of minute ones following the great group by about 8 minutes of arc. 200 X used."



Langley's rice-grain drawing

LAST month this department was stowed to the scuppers with hard-to-read brain stuff about the Special-purpose RFT, so we compensate this month by unloading a collection of levity that has been accumulating for the past year or two.

Some months ago we published a sketch by Russell W. Porter, showing the precautions that are being taken at Pasadena to

prevent those connected with the work on the 200" mirror from bringing in grit on their shoes. Their shoes have to be discarded at the doors and special indoor footwear substituted, just as American tourists (if any go there now) have to do before entering Japanese sacred temples. At that time we said to Mr. Porter that, when the actual polishing on the 200" disk was begun, we supposed there would be a microscopic examination of everything down to the grit in the workers' whiskers, and suggested a cartoon depicting the grand clean-up to come. It takes only a suggestion to start Porter making a drawing, and the result is on page 122—the final search for about two lost, lonely, little sub-microscopic particles of potentially trouble-making grit.

NEXT item was drawn by Maxfield Parrish, Jr., 3140 Holmes Ave., Minneapolis, Minn., who regularly reads this column, even if he hasn't yet admitted making anything more telescopically tangible than awful caricatures of himself. Parrish probably inherited his ability with the pen from his famous father.

COMES next a cartoon, not of himself but of his older brother, a TN, drawn by Harvey L. Hinshaw, aged 11 years, 935 N. Oakland Ave., Pasadena, Calif.—a future Maxfield Parrish, it would seem, also one with a proper understanding of the typical Telescope Nut.

AND now for three poets. First poet, R. W. Porter who has evidently been reading roadside rhymes advertising Burma Shave:

Si am de man
Who t'inks he can
Make 'scopes from
Readin' ol' Sciam.

And another:

From { Waukesha, or
Saskatoon

To { Far Siam, or
Alabam'

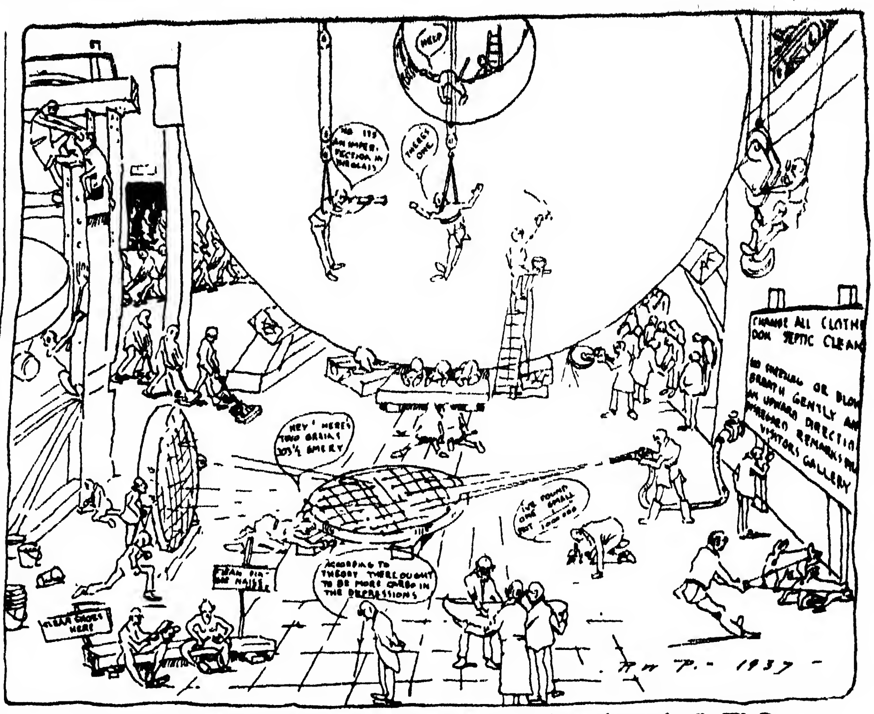
You'll find 'em
The Nuts are } readin'

Ol' Sciam

Here's one that comes nearer home:

She threw up her hands
And let out a "Damn!"
"You've ruined my kitchen.
A curse on Sciam."

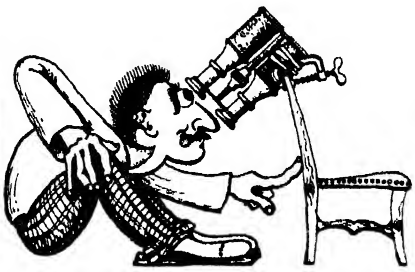
WAY down on the Gulf Coast, at Biloxi (pronounced Bluxy), Miss., lives the Fred ("Amos") Ferson who wrote the chapter on molding and casting telescope parts, ATMA, page 349. Ferson is a personable red-head who knows the common working negro of the Deep South and the twists of his language from way back. The following is his "Soliloquy of Cotton-Pickin' Sam." Perhaps the northern reader will find it more difficult to follow Ferson's rendition than the more familiar but less accurate sort used by us northern writers; the same is true of Joel Chandler Harris's Uncle Remus stories. The late S. H. Sheib of Richmond used to assert that most northern writers evidently obtain their idea of negro dialect from other northern writers, as it is not accurate. For example—and the same



Preview of the world's fussiest housecleaning job, as drawn by R. W. P.

example appears in the second line of Ferson's verses—the word "till." Writers often render this as "twell," but with the Deep South negro of the cotton-field type it is plain "to." Similarly, "they" is not "dey" but "dee."

Ah is sho worri'd de boss-man's los his mine.
He polishin glass to hit git slick en shine.
Den he say he gwine gib hit er figgah
Ez purty ez a gal—mebbe mo biggah.
En see de stahs, en see em double.
Hit sho ez meant er heap er trouble
To see dem stahs.



Self-portrait, by M. Parrish, Jr.

De cellah am red—an so am us.
Dat rouge am spead in bright red dus
To de omelet look ez red ez blood,
En mo lak dish-yer Alabama mud.
En de wash watah show de same red, too.
Boss, whyn't yo use somepin blue
To see dem stahs?

He talk er laps er rosin en terps.
Hit sticky ez one er dese yaller cur purps.
He talk er tools en read de book,
En stiddy and stare wid a vacant look.
Hit allus too hot, too wet, er too cold.
He keep dat up, he nevah git 'nuff old
To see dem stahs.

Mah fun doan costes no starin' ter see
De gals, er mah banjo on mah knee.
Hit jes raise up in de great big bubbles.
Ob cose de gals kin be de troubles,
(En de hoe er misery in dat long cotton).
But mah situashun ain't so rotten—
Why look at stahs?

Ah nevah thunk ah'd lib ter see
De boss-man stang wid sech a bee,
Er dat he'd stop cussin us niggahs
Fer laps en tools en crazy figgahs.
Ah sho hopes he be hissef soon
En red er de eetch fer planets en moon,
En ter see dem stahs.

THIRD poet, Leo Cotton, is also an artist. He is a member of the Turned-edge Brotherhood of the Los Angeles Astronomical Society, and is with the Art Department of the *Los Angeles-Examiner*. The sketches are his.

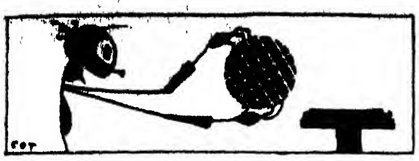
Pyrex, elbow-grease and smear;
A run-around—you have a sphere.

If center deepens, you must hedge—
Shorter strokes will work the edge.

Another way that edge to drop,
Is using tool a while on top.

When pencil marks and depth agree
You switch to number two, sez we.

In a younger brother's opinion



Number eighty's now a pest,
Clean up well and scrape your vest.

Go round and round, nor call it quits
Till scratches leave, and ditto pits.

One third stroke should be the rule.
Watch zonal contacts, juggle tool.

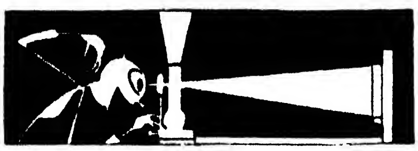
Half below and half on top,
Middle's up when edges drop.

Remember that a finer grade
Erases what a coarser made.

Round and round, an endless tread,
Work foot and arm, and so-called head.

After number seven, switch
To polishing by using pitch.

Pour it; facet; press and wax.
Time 'twill take and patience tax.



Then the treadmill, round and round,
Rouge will polish where 'twas ground.

Scan anon with 'Foco' test,
To spot out where your mirror's messed.

Strive to get that doughnut look,
Don't ask me how--go buy a book-

The 'bible' of the scopers - them
What's in the know calls ATM.

And when 'tis finished, friend and brother,
You'll soon be making you another.

And if it turns out not so good,
Join the Turned-edge Brotherhood.

AN embargo on doggerel, rhymes, verse - yea, even poems is hereby declared for the year 1938, and longer unless there is evidence that the readers have fully recovered from the above fits of frivolity. Even now, your scribe fully expects his hide will be nailed to the barn door by some of the readers, not those of this department but of the magazine in general. Once an old "Sciam" reader did this because, *horror horribilis*, he saw, right in Scientific American, "a *cartoon!*" Hence, to non-telescope-making readers we explain: This amateur telescope-making hobby is scientific but it is also human; dive in and enjoy some of the sport yourselves.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

BETTER PHOTOGRAPHY MADE EASY is a 62-page spiral bound book with heavy cardboard covers that gives many hints as to how the amateur photographer may improve the technical quality of his photographic product. Essentially elementary, it presents many phases of photography that will be of interest to every camera owner; it is replete with excellent photographs, many of them illustrating the right and wrong way to do a particular job. *Willoughbys, 110-114 West 32 Street, New York City. 10 cents.*

THE MONTHLY STAR FINDER is an eight-page pamphlet, issued every month, which presents a star map for the current month, information on eclipses, interesting short articles on various phases of popular astronomy, and so on. Of value to all amateur astronomers. *The Monthly Star Finder, Observation Roofs, 30 Rockefeller Plaza, New York, N. Y.—10 cents a copy, $1.00 a year.*

PRIMACORD BICKFORD DETONATING FUSE is the title of a 20-page pamphlet describing the construction and use of a new detonating fuse for modern blasting. The advantages of this new fuse—speed of the explosive wave, efficiency, economy, and ease of handling—are put forth in the illustrated text. *Write for Bulletin 238A, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE FORMATION AND CHARACTERISTICS OF PENNSYLVANIA ANTHRACITE has been prepared to answer numerous questions which are frequently asked regarding the production, distribution, and utilization of anthracite. It is in the form of a 34-page pamphlet, well-illustrated, and will be of particular interest to those who use anthracite in home heating plants; it gives many hints for efficient operation that otherwise might never be found. *Anthracite Industries Laboratory, Primos, Pennsylvania.—15 cents.*

LIGHT-GAGE FLAT-ROLLED STEEL IN HOUSING, by F. T. Llewellyn, is a technical publication which describes the use of steel in building construction and shows by means of comprehensive drawings and photographs just how it is applied. *Write for Bulletin 238B, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PART-TIME FARMING IN THE UNITED STATES is a statistical analysis of a problem which has a definite bearing on agriculture in general. It includes a large number of maps and data presented in tabular form. *Superintendent of Documents, Washington, D. C.—50 cents (coin or money-order).*

THE NEED FOR INCREASED RAILROAD REVENUES is an 18-page pamphlet that gives the essential facts regarding the railroad's place in the United States at the present time. Based upon the premise that prosperous railroads are essential to a prosperous nation, it presents data showing that while other prices have been increasing, railroad rates have been decreasing and that the margin between income and outgo is too thin for satisfactory operation. Statistics and facts are included. *Write for Bulletin 238C, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

DEVELOPING AND PRINTING MADE EASY is a comprehensive primer on the subject that will enable any amateur photographer, no matter how unskilled, to produce satisfactory negatives and prints if he will only follow the specific directions given. It is lavishly illustrated with beautiful examples of photography. Included are a list of defects in negatives and prints and how to remedy them, as well as a series of recommended formulas. *At your photographic dealer or from Agfa Ansco Corporation, Binghamton, New York.—25 cents.*

NICKEL ALLOY STEELS FOR HAND TOOLS deals with the various types of tools which can be improved by the use in manufacture of the correct type of alloy steels. Illustrated with photographs and with charts showing the mechanical properties of various nickel steels. *Write for Bulletin 238D, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MACHINES AND WORKING HOURS is an argument against shorter working hours as a result of industrial mechanization. It shows how mechanization creates more jobs than it destroys, how increased production demands increased man-hours, and how the work week is being reduced out of all proportion to increased output per worker. The plea is essentially for a better balance between the workman and the machinery which he controls. *Machinery and Allied Products Institute, 221 North La Salle Street, Chicago, Illinois.—Gratis.*

MOLYBDENUM TODAY is a beautifully prepared booklet, 9¼ by 10½ inches, which presents in picture and text the story of molybdenum and its industrial applications. *Write for Bulletin 238E, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE WARM SPRINGS OF GEORGIA, Their Geologic Relations and Origin, is a summary report, by D. F. Hewett and G. W. Crickmay, which includes several large folded maps and a separate color map of the Warm Springs Quadrangle. *Superintendent of Documents, Washington, D. C.—25 cents (coin or money order).*

THE ORIGIN AND DEVELOPMENT OF RADIOTELEPHONY, by Lloyd Espenschied, is Monograph B-1021 of the technical publications of the Bell Telephone System. It gives a highly interesting and informative background of radiotelephony, dips briefly into the future of the science, and includes an excellent bibliography. *Bell Telephone Laboratories, Inc., 463 West Street, New York City.—Limited Free Distribution.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

STILL FIGHTING

THE far-reaching consequences of the World War and its effect upon our political and economical life have been discussed so frequently that everyone is familiar with the subject. Few people realize, however, that the World War is directly responsible for some of the litigation pending in our courts at the present time.

A rather interesting case growing out of the World War was recently decided by one of the Federal District Courts. The plaintiff brought suit to recover several patents and a patent application from a dye manufacturer on the grounds that the subject matter of the patents and patent application were seized during the World War by the Alien Property Custodian and assigned to the plaintiff.

The facts in the case are somewhat complicated. It appears that a German invented a new dye and applied for patents in Germany and France in 1914 and in the United States in 1915. The French patent was granted in 1916. However, probably due to the difficulties caused by the World War, the United States patent application was abandoned in 1917. Subsequently, in 1918 the patent attorney for the German inventor filed a new application in the United States, signing the inventor's name to the application without his authority.

Under the Trading with the Enemy Act, the Alien Property Custodian seized the patent application which was signed by the attorney, and the Alien Property Custodian in turn assigned the application to the plaintiff. Due to various difficulties, no patent was ever granted on this application.

In the year 1921, the so-called Nolan Act was passed by Congress which permitted the filing of patents on certain inventions which had been developed during the period of the World War or just prior thereto even though the inventions had been patented in foreign countries.

Under this statute, the German inventor filed a new application in the United States in 1922, and this application resulted in the two patents and in the patent application which formed the subject matter of the suit.

The plaintiff contended that since the patents and patent application owned by the defendant related to the same subject matter as the application which was seized by the Alien Property Custodian during the World War they really belonged to the plaintiff.

The Court rejected this contention, stating that the application which was seized by the Alien Property Custodian during the World War was a nullity and that he actually acquired nothing. In support of this conclusion, the Court pointed out that the application seized by the Alien Property Custodian was not signed by the inventor as required by our statutes but was signed by the attorney without authority. The Court also pointed out that at the time that the seized application was filed, a patent had issued in France on the same invention and this was a bar to the American application. Since the Alien Property Custodian had seized a patent application which was a nullity, the plaintiff had acquired no rights by assignment and, accordingly, the German inventor had a perfect right to file a new application under the Nolan Act and dispose of it as he saw fit.

PEP

SLANG was accorded judicial recognition in a case decided by the Circuit Court of Appeals for the Fourth Circuit.

It appears that the plaintiff in the case under consideration manufactured a soft drink under the trade mark Pepsi-Cola, and he brought suit against a competitor who was using the name Pep-Ola to designate his soft drink. The Court enjoined the defendant from using the name Pep-Ola because of its similarity to Pepsi-Cola. Thereafter the defendant designated its soft drink by the name Pep, and the plaintiff sought to restrain this on the grounds that it was confusingly similar to its name Pepsi-Cola. The Court rejected this contention, however, and permitted the defendant to continue using the name Pep on the grounds that the name was a slang expression which had acquired a well-known meaning and was descriptive of the defendant's product. Because of this, the Court concluded that the defendant had a perfect right to use the word Pep to designate its product.

In reaching this conclusion, the Court stated: "'Pep' is a slang word that has come to have a well-known and generally accepted meaning in our language. Presumably derived from the word 'pepper,' it is in use generally as denoting vim, vigor, energy, or anything that will impart those or similar qualities when a food or drink is used. It is defined in Webster's Dictionary as 'effective energy or power.'"

ALL THE SAME

A MAP is the same as a book from the standpoint of copyright registration. This is the substance of a recent ruling by the Federal Court for the Southern District of New York. In that case the plaintiff was the owner of a copyright on a guide pamphlet containing a map of New York City and also certain guide material and directions. The defendant published a guide booklet consisting of an aerial photograph of New York City and guide material and directions which were similar to the material and directions in the plaintiff's booklet. In registering its copyright plaintiff had classified its booklet as a map. Defendant contended that the copyright only protected the map and that accordingly defendant was not guilty of copyright infringement, because his photograph was not a copy of plaintiff's map and the printed guide material and directions were outside the scope of the copyright. The Court agreed that defendant's photograph of New York was not a copy of plaintiff's map, but rejected the contention that the copyright did not protect the guide material and directions. The copyright afforded full protection to everything contained in the guide booklet, the Court held, and should not be defeated by the technicality that in registering the copyright it was classified as a map. In this connection the Court stated:

"It will not do to be over strict as to the technicalities of the Copyright Act. The Act itself, in Section 5, as amended, provides that error in classification shall not impair copyright protection. If the statute is substantially and in good faith complied with by a person seeking copyright protection and if others have not been misled into thinking that the work is not copyrighted, it is enough."

HELPFUL CONTROVERSY

INVENTORS usually feel injured when innumerable references are cited against their patent applications, and the injury turns to insult when the applications are placed in interference. However, if it is able to weather the storm, a patent resulting from an application having a tortuous and difficult history in the Patent Office is frequently accorded much more respect by the courts.

In a recent suit for patent infringement decided by the Circuit Court of Appeals for the Sixth Circuit, one of the patents in suit related to an automobile piston. While the application for patent was pending in the Patent Office, most of the pertinent art was cited and considered by the Patent Office. The application was involved in interference and the patentability of the invention was questioned during the course of the interference proceedings. The Court held that where the invention was so thoroughly considered by the Patent Office tribunals the presumption of validity which normally attaches to a patent was strengthened. Partially on this basis the patent was adjudged to be valid. In reaching its conclusion the Court stated:

"Where, as in this case, substantially all pertinent prior art has been cited against the patent, where, in hard fought interferences, novelty and invention have been challenged, and where priority of conception has been finally adjudicated only upon repeated review in both administrative and judicial forums, the patent should not be stricken down except upon very clear and convincing proof of invalidity."

The reason underlying this attitude is that the considered opinion of the patent-office tribunals, formed of experts in their fields, should not be lightly disregarded.

Books SELECTED BY THE EDITORS

THE DIARY OF A SURGEON

By John Knyveton

AN odd book. Based on the discovery of an 18th Century diary of a doctor in England, which gives a ghastly, gory picture of the horrors of being ill in those days of filthy hospitals and ignorant medical treatment, it sets the reader straight down in the smelly atmosphere of those lovely (?) times. For example, the young medical student writes in his diary on December 13: "Dissected the trunk this morning and was greatly edified to find the Guts full of Worms." His accounts of public hangings are really choice, as are those of the medicos' creepy midnight body-snatching for dissection: January 5: "Was up all last night Corpse Taking. We found the hanged wench and dragged her out and put into the sack, which Mr. Pope and I did then carry between us all mired and sweaty." And so on through 322 lugubrious pages. Grand reading, but not for the squeamish—$2.65 postpaid. —*A. G. I.*

MANUFACTURE OF WHISKEY, BRANDY, AND CORDIALS

By Irving Hirsch, LL.B., LL.M., Chemical Engineer, Technical Consultant

FOR the distiller, either expert or apprentice, this volume will prove a mine of information. It covers the manufacture of whiskey, brandy, and cordials completely from the preparation and combination of ingredients to the final blending and bottling. Some of the chapter headings, which indicate its scope, are as follows: Whiskey; Treatment of the Grain; Distillation; Equipment and Appliances; Manufacture of Brandy, Applejack, Pear Brandy, and others including miscellaneous liquors; Blending; Maturing of Spirits; Artificial Maturing; Clarifying; Coloring; and so on. A chapter is devoted to government regulations and a long section is devoted to useful tables. Printed by the photo-offset process, the text appears only on right-hand pages, the back of each sheet being left blank. This provides for a page of memoranda opposite each text page. -$10.20 postpaid.—*F. D. M.*

THE NEW MODEL AIRPLANES

By Elmer L. Allen

HERE indeed is a practical manual on the construction of model airplanes. The text tells how to build and fly gliders, exhibition models, scale flying models, and about miniature motors for model aircraft. Complete designs are given for various models including a gas-powered monoplane. A separate chapter is devoted to propeller carving. With no other instructions than those contained in the book a model builder could easily construct any one of the miniature planes described.--$3.15 postpaid. —*A. P. P.*

EXPERIMENTAL SET FOR TESTING EXTRA-SENSORY PERCEPTION

NOW that Prof. J. B. Rhine's Duke University card-matching experiments, apparently proving the validity of telepathy and clairvoyance, have been verified by a number of psychologists at other universities—though not by all—and his book "New Frontiers of the Mind" which explains these tests has become a best-seller, people all over the nation are trying the tests themselves. This is simple to do. This test set contains (1) Stuart and Pratt's 96-page "Handbook for Testing Extra-Sensory Perception" containing direct instructions for making the tests, with a foreword by Prof. Rhine; (2) a record pad for accurate scoring; and (3) two packs of the same ESP cards that are used at Duke. These tests are disproving the old belief that extra-sensory perception is confined to professional psychics; in some of Rhine's experiments plain ordinary people have out-psychicked the pros.—$1.90 postpaid.—*A. G. I.*

ATOMIC ARTILLERY

By John Kellock Robertson, Prof. Physics, Queen's University, Canada

A MEDIUM size book which tells in plain language the story of electrons, protons, positrons, photons, neutrons, and cosmic rays, as well as the methods used in the transmutation of the elements and manufacture of artificial radioactivity.—$2.40 postpaid.—*A. G. I.*

WILDCAT

By William Heyliger

FICTION founded on fact is the keynote of the present book. Essentially the story deals with two young oil-field workers who "poor-boy" an oil well—successfully, of course, as in all fiction. The story is easy reading, gives an authentic background of modern seismological prospecting and of oil-well drilling methods, and will in this reviewer's opinion hold the reader fascinated until he reaches the last line.—$2.15 postpaid. —*A. P. P.*

SOUND

By Arthur Taber Jones, Prof. Physics, Smith College

AN all-around textbook on sound, suitable for readers who have covered elementary physics. The chapters deal with the production of various noises, vibratory motion, simple tones and combinations of tones, musical scales, transmission of sound, free vibration, forced vibration and maintained vibration, hearing, musical instruments, speech and song, and the commoner technical applications of sound. Anyone desiring to work up a thorough grounding in the science of sound will find it here in compact form.--$3.95 postpaid.—*A. G. I.*

EXPLORING THE HEAVENS

By Clyde Fisher, Ph.D., LL.D.

THE Head of the Hayden Planetarium in New York and Curator of Astronomy at the American Museum of Natural History has set down in this book the substance of most of the public talks on astronomy given at the planetarium, but not in lecture form. It deals with the earth, sun, moon, seasons, comets, meteors, origin of the solar system, stars, nebulae, aurora and the constellations at some length—a fair cross-section of popular astronomy. Very popular, of course —a book for your mother, sister, or son, and for you if you have never read any book on astronomy. -$2.65 postpaid.—*A. G. I.*

SCIENCE AND MUSIC

By Sir James Jeans

TEXTBOOKS of physics usually include short sections on the science of musical sounds—short but not too sweet. What Jeans has now done is to expand such accounts into a 259-page, non-mathematical, illustrated book, at the same time sweetening it by detailed, explicit explanations which anyone of high school mental age can follow. Such a book has long been needed. He starts at the very beginning and the attentive reader will feel at the end like a Bachelor of Harmonics, a Master of Sound Analysis, a Doctor of Piano and Organ Tone,

and a Professor of Musical Scales, and be able to out-talk most of his musical friends on the underlying *reasons* for many things musical.—$2.90 postpaid. —*A. G. I.*

COLLISIONS IN STREET AND HIGHWAY TRANSPORTATION

By Barry Mulligan

WHAT is to be done about safety on the highway? The problem is one that revolves largely around collisions; a study of collisions and their causes makes possible pertinent suggestions as to remedies. This is just what the present author has done, and he has presented his findings in textbook form which is nevertheless entirely readable and interesting for the layman. In addition, the carefully worked out and segregated sections can render invaluable aid to public officials, highway engineers, and everyone directly or indirectly concerned with highway transportation.—$3.15 postpaid.—*A. P. P.*

COMMON NEUROSES OF CHILDREN AND ADULTS

By O. Spurgeon English, M.D., and Gerald H. J. Pearson, M.D.

A CLINICAL professor of psychiatry and an assistant professor of pediatrics at the Temple University Medical School are the authors of this detailed practical treatise which should assist perplexed parents in understanding emotional peculiarities in their children and in adults—such things in children as nightmares, phobias, nail biting, speech disorders, refusal to eat, bed wetting, involuntary movements, "scrappiness," stealing, perversions, and in adults the typical neurotic traits. It is written understandably and clearly.—$3.65 postpaid.—*A. G. I.*

TRICKS, TOYS, AND TIM

By Kreigh Collins

FROM a model of a flat-bottom sailboat to a realistic working "six gun," from a model water-powered elevator to magicians' tricks, this book runs a gamut of fun for anyone who likes to use his hands. If you have a youngster from 6 to 16 years of age, you might purchase the book for him. If you do, there is very little doubt but that you yourself will do most of the reading and a lot of the construction.—$2.15 postpaid.—*A. P. P.*

A BEGINNER'S STAR BOOK

By Kelvin McKready

AN old standby newly and thoroughly revised. Objects to be seen, learning to observe, instruments, star maps—this is the general scope of the book, which is excellently suited to the needs of the amateur either with opera glasses or with two-inch or three-inch (or somewhat larger) telescopes, and the objects to be seen are arranged in these categories for each month. It contains a catalog of telescopic objects with description of each, also compact data on general astronomy though it is not a textbook. The charts facilitate systematic survey of the show-features of the heavens and learning the constellations. —$3.70 postpaid.—*A. G. I.*

MAKING PICTURES WITH THE MINIATURE CAMERA

By Jacob Deschin

NEW in conception, new in its treatment of various phases of photography, new in its physical makeup, comprehensive in every sense of the word, is this latest addition to the rapidly growing literature of amateur photography. The editors may be permitted a certain amount of pardonable pride when pointing out that the author is conductor of the highly successful and widely read column "Camera Angles," which appears every month in Scientific American. We are as proud of Mr. Deschin's new book as we are of his work in bringing "Camera Angles" to its present popularity.

Mr. Deschin's latest book is compacted to the last degree—all bones and red meat, no excess fat. It takes the reader by the hand and tells him specifically how to do certain things with his camera. It takes nothing for granted, giving complete directions, accompanied by comprehensive illustrations. The introduction tells something of the general art of photography, whereupon the text plunges directly into how to make portraits, animal pictures, street scenes, and all other things photographic. The author then deals with the work in the darkroom—developing, printing, enlarging, in all their phases. The all-inclusive text is topped off with a gallery of 45 full-page prints, many of which illustrate some specific point that has been dealt with in the forward part of the book. 6¼ by 9¼ inches.—$3.15 postpaid.—*A. P. P.*

LIFE LONG AGO

By Carroll Lane Fenton

THE story of fossils, for boys and girls of the inquisitive age. An authentic, well-illustrated, popular account of the various geologic eras, periods and epochs, and their characteristic life, including the giant extinct reptiles and mammals. For some reason fossil man is omitted.—$3.70 postpaid. —*A. G. I.*

ASTRONOMY FOR THE MILLIONS

By G. Van den Bergh

A RATHER elementary exposition mainly of the more elementary parts of astronomy—in fact, it sounds written down and school-teacherish in tone (which, however, is just what many readers who are willing to admit their difficulties—introverts—frankly want). It covers the science of astronomy from the earth to the universe, with more emphasis on the difficulties of understanding the homely phenomena of motion and position and things within the solar system than on current advances in astrophysics.—$3.70 postpaid.—*A. G. I.*

HOW TO MAKE ELECTRIC TOYS

By Raymond F. Yates

YOUNGSTERS old and young will find in this 200-page book a wealth of information about how to make simple little electrical gadgets that will afford hours of pleasure. Secret magnetic locks, experiments with coils, an electric alarm, an electric chair for bugs, magic magnetic boats, a shocking coil, and a dozen or so other and equally interesting gadgets are described. Fully illustrated with drawings and photographs of the things about which the author writes. $2.15 postpaid.—*A. P. P.*

THE PAGEANT OF THE HEAVENS

By Frederick Warren Grover, Prof. Union College

A NEW elementary star book. In addition to six seasonal constellation charts, also two circumpolar charts (all these are white on black background —probably the clearest method), there are 157 pages of mixed elementary descriptive matter on the constellations, the solar system and the universe. Pages 8 by 10 inches.—$3.20 postpaid.—*A. G. I.*

AN INTRODUCTION TO THE PHILOSOPHY OF SCIENCE

By A. Cornelius Benjamin, Asst. Prof. of Philosophy, University of Chicago

A TEXTBOOK treating of the problems in the logic of science (symbols, perception and so on); problems in the analysis of the concepts of science (order, number, quantity, space, time, law, course); and speculative problems (free will, reality and so on). It largely lacks reader appeal and will be slow going except for the industrious.—$3.70 postpaid.—*A. G. I.*

For sale by
SCIENTIFIC AMERICAN
24 West 40th Street
New York City

SCIENTIFIC AMERICAN

ADVERTISERS

February · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York
ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 158, No. 2. 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • MARCH • 1938

FROM potatoes to petunias, from soy beans to snapdragons, the work of the professional plant breeder runs the whole gamut of agricultural crops and garden flowers. By such efforts, as told in the article starting on page 133, many of our common vegetables and flowers have been bred into forms far different from the originals. The plant breeder shown on our front cover is working with snapdragons. Note the individual flower spikes that have been bagged to insure self-pollination. ***(Courtesy Bodger Seeds, Ltd.)***

SCIENTIFIC AMERICAN, March, 1938. Vol. No. 158, No. 3, entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 Years Ago in . . .

Scientific American

(Condensed From Issues of March, 1888)

FORTS—"Now that Italy inclines to German alliances, the French are seeking new means of strengthening their eastern or Alpine frontier, and the French military press is urging more haste in the construction of the cordon of forts which the general staff is organizing along the giant hills that separate the republic from the kingdom of Italy."

BLIZZARD—"The recent great storm will not have been without some good results if it energizes the efforts of those seeking to introduce some hitherto obviously needed public improvements. . . . Among such improvements that have long been urgently called for, one is that of putting underground at least a portion of the telegraph and electric light wires in all large cities, and burying some of the telegraph lines connecting the most important commercial centers. It would be ludicrous, were it not too serious a matter, to think of telegraphic messages being sent between Boston and New York *via* London, 6,000 miles under the ocean, as was necessary on March 12 and 13. While passenger and freight trains were stalled in snow drifts all the way from Boston to Baltimore, the telegraph service of the country was suddenly paralyzed."

CHIMNEYS—"A well proportioned chimney, of neat design, from 200 to 300 feet high, is always an imposing structure and an ornament to a large manufacturing establishment, but it may well be questioned if it is ever worth while to build them over 150 feet high. Where cost is no consideration there is no objection to building them as high as one pleases; but for the purely utilitarian purpose of steam making, we have yet to find a case where it was necessary to build a chimney more than 150 feet high."

NAPHTHA—"One of the largest naphtha fountains yet known has lately broken out near Baku, which threatens to inundate all Balakhani. The naphtha, owing to the pressure of the gases which accompany it, rises to a height of from 280 to 420 feet, and is carried away by the wind to a great distance, falling like fine rain at the more distant parts of the district, but near the fountain coming down in torrents that form rivers and streamlets."

BOOMERANGS—"According to a German manufacturer, who has made some 11,000 toy boomerangs, the mystery of the movement lies in the shape, the boomerang having a sharp curvature in the middle, with unequal length of the two arms, which must be made of equal weight by unequal thickness. The peculiarity of motion is said to be due to the difference in the length of the arms, which diverges the curve of rotation from the circular."

FROZEN SAND—"A recent number of the *Annales Industrielles* states that a mine shaft is being successfully sunk by M. Alexandre, of the Houssu Company, in Belgium, through a stratum of moist sand 12 m. thick, met with at 70 m. depth, by the Poetsch method, which consists in freezing the sand, then excavating it like rock."

SPIDER—"The habits of the running spider of southern Europe, *Tarantula narbonensis*, Latr., studied by Herr Beck, are curious. It makes a vertical round hole in the ground about ten inches deep, and this . . . is lined with web. A little way down is a small lateral hole, into which the spider shrinks when an animal falls into the tube; when the animal has reached the bottom, the spider pounces on it."

SHIP RAILWAYS—"The air is full of ship railway projects for all parts of the globe. The ship railway over the Chignecto Isthmus is already under contract. A ship railway has also been surveyed across the Florida peninsula to save the 600 miles of distance around and through the straits. . . . The great work in all this programme, both as to the magnitude of its construction and its results, is the Tehuantepec ship railway. . . . Perhaps it is too much as yet to say that the age of ship canals is giving way to that of ship railways, but M. De Lesseps can hardly be expected to feel quite at his ease in the presence of this new and vigorous movement."

WITH CHAMPAGNE—"The illustration shows a method of performing a neat dessert experiment. When a grape or raisin is allowed to fall to the bottom of a glass of champagne, bubbles of gas are observed to attach themselves to it. This causes the grape or raisin to rise to the surface, where the bubbles burst. Then it sinks, and afterward begins its ascent again. The bubbles of carbonic acid gas perform the rôle of minute balloons ascending in the liquid and carrying the object with them."

PASTEUR TREATMENT—"The municipal authorities of Barcelona, as we announced last year, have established a municipal microbiological laboratory, mainly with the view of enabling persons bitten by rabid animals to obtain the advantages of Pasteur's method of treatment. . . . Altogether eighty-five persons have been subjected to the treatment. Of these, twenty-five had been bitten by animals that were certainly rabid, fifteen by those which had been pronounced rabid by medical men or veterinary surgeons, and thirty-seven by animals which were believed to be rabid, but whose condition could not be verified by professional men. The remaining eight persons had not been bitten at all, but submitted to the process in order to prove its harmlessness. . . . Not a single case, either of those who had been bitten or of those who had not, proved fatal."

FALLS—"According to a recent calculation, the highest waterfalls in the world are the three Krimbs Falls in the Upper Prinzgau; these falls have a total height of 1,148 ft. The three falls next in height are found in Scandinavia—the Verme Foss, in Romsdal, 984 ft.; the Vettis Foss, on the Sogne Fjord, 853 ft.; the Rjuken Foss, in Thelemarken, 804 ft."

DUST EXPLOSIONS—"The *Milling World* reminds millers of the oft-proved fact that flour dust is a dangerously explosive material. Beware, says the editor, of lights thrust or carried into bins or rooms filled with dust-laden air."

AND NOW FOR THE FUTURE

Industrial plant lighting and its effects on production and personnel, by A. K. Gaetjens.

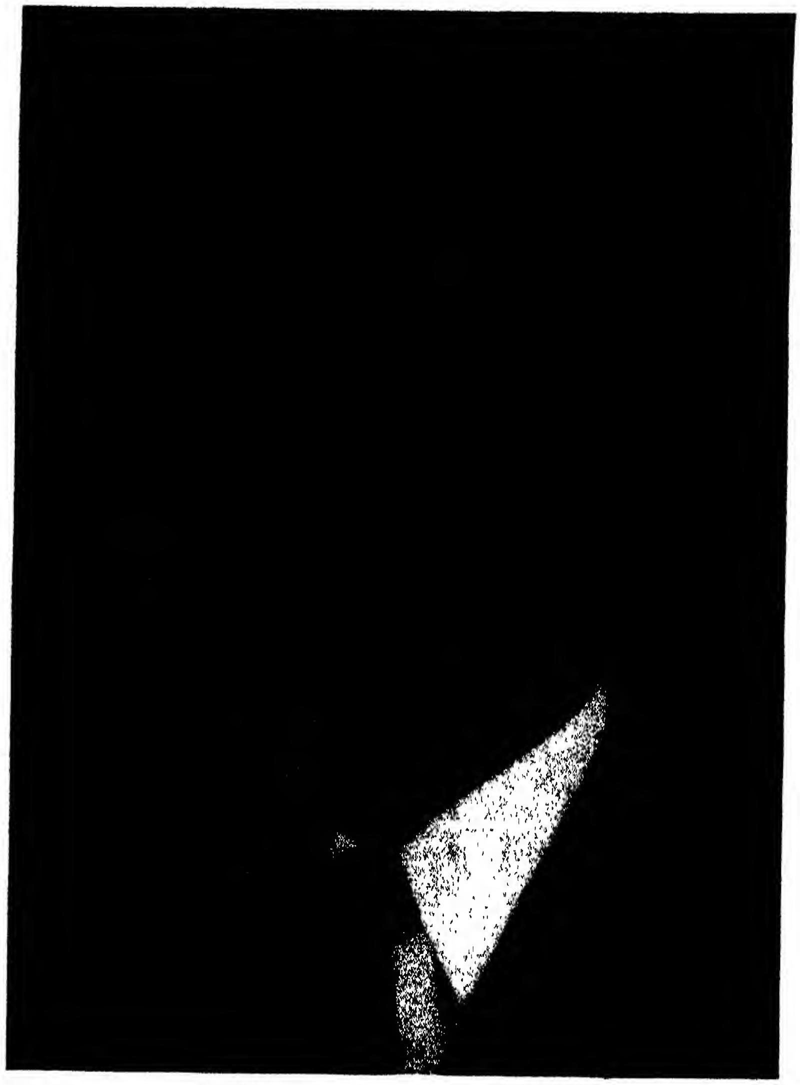
Construction of a streamlined train from strip steel to finish.

Why some metals are soft and yielding, others hard and brittle, by Sidney J. French, Ph.D.

What is definitely known of the phenomenon of the Northern Lights, by Prof. A. S. Eve, F.R.S.

New light on the Sumerians, the problem child of Oriental archeology, by E. A. Speiser.

Personalities in Science



DR. LINUS PAULING

PRONOUNCED six years ago to be the most promising young American chemist in 1931 (Scientific American, November 1931, page 293), Dr. Linus Pauling, then aged but 30, has now emerged a mature and definite "personality in science." His recent appointment to succeed the late Dr. Arthur A. Noyes as Director of the Gates-Crellin Chemical Laboratories and Chairman of the Division of Chemistry and Chemical Engineering at the California Institute of Technology, substantiates the brilliant predictions made for him in 1931 when he received the Langmuir Award in Pure Chemistry. Dr. Pauling was the first to receive this annual chemistry prize which has since been captured by some of his abler students.

To be given a departmental directorship at the age of 36 bears witness to the confidence and respect of his colleagues and fellow scientists. Dr. Pauling has served a thorough apprenticeship as student, friend, and admirer of Dr. Noyes, who was one of the most outstanding physical chemists of the last generation.

Professor Pauling's interest in chemistry dates from early boyhood, and it was while a student in chemical engineering at Oregon State Agricultural College that he chose it as a life work. G. N. Lewis' work on the electron bond, which came to his attention as a sophomore, was, he tells us, a profound factor in affecting his decision. Following graduation from college in 1922, he went to the California Institute of Technology for advanced study. While working there for his doctorate, obtained in 1925, he carried out his famous early research on crystal and molecular structure under the direction of Dr. Roscoe G. Dickinson. One of the most formative opportunities of his career then came to him as a Guggenheim Fellowship which took him abroad for 19 months. He studied under Bohr at Copenhagen, Sommerfeld at Munich, and Schrödinger at Zürich. Schrödinger was at that time just publishing his first papers on wave mechanics, so the young chemist was present on the very frontier of the new theory of quantum mechanics. In 1927, he was appointed Assistant Professor of Theoretical Chemistry at the California Institute of Technology, in Pasadena, and in 1931 he was given a full professorship.

Professor Pauling's research field is diverse and varied. His most important recent work deals with the determination of the structure of gas molecules by diffraction of electron waves. But he is not limited to one specialty. His range includes as well the applications of quantum mechanics to chemistry, rotation of molecules in crystals, theory of stability of complex crystals, sizes of ions, the chemical bond, line spectra, and the structure of hemoglobin and other natural substances. For the past few years, a grant from the Rockefeller Fund has been at his disposal for carrying on these researches with a group of 12 or more men under him. His program correlates these problems into an interrelated system in which about half of the time is devoted to experimental and half to theoretical methods, thereby rendering the system more powerful. European scholars come from many points to work under Dr. Pauling. He and his associates have contributed many papers in these fields, and he has published two books, "Structure of Line Spectra" (Pauling and Goudsmit), 1930, and "Introduction to Quantum Mechanics" (Pauling and Wilson), 1935. He is a member of the National Academy of Sciences and the American Chemical Society, and serves as an associate editor for the American Chemical Society Journal. As a lecturer in chemistry, he has been associated with the Massachusetts Institute of Technology and the University of California.

Professor Pauling gave the George Fisher Baker Lectures in Chemistry at Cornell University during the autumn semester of 1937-38. While there, he gave some 30 lectures on the nature of the chemical bond.

Personally, this scientist is not the formal being his achievements might presuppose. He and his beautiful young wife are in popular demand on the campus. Equally hospitable to struggling student or visiting professor, their home, enlivened with four bright children, reflects intellectual charm and true *joie de vivre.*—*Susan Hartley*

Photo by R. Schudel

A FORTRESS OF SCIENCE ON A MOUNTAIN PEAK

RECENTLY dedicated was the new Meteorological Observatory Jungfraujoch, on the peak of the Sphinx, 11,716 feet above sea level in the Swiss Alps. Reached by way of the Sphinx tunnel of the Jungfrau railway, a connecting tunnel, and a 364-foot elevator, the observatory has been built not only for making routine meteorological records, but also to afford scientists an opportunity for research work in astronomy, physics, cosmic rays, aerodynamics, and so on. A glass-enclosed veranda in the observatory building and terraces on the east and west sides are open to sightseers.

Stock-seed plots on a California flower seed farm. As seed from these plots is to be used for seed-production purposes the following year, every effort is made to eliminate during the blooming season all plants but those with desired characteristics

STREAMLINED PLANTS

Professional Plant Breeding . . . Benefits the Farmer, the Housewife, Many Others . . . Finer Fruits, More Beautiful Flowers, Tastier Vegetables

By KEITH C. BARRONS

THE work of the professional plant breeder is not designed to aid the farmer alone. Everyone who produces, processes, or consumes plants and plant products is benefited in no small way by the breeder's efforts to mold superior heritage in agricultural crops. This includes everyone from the grower, whose yields are increased and income made more certain by improved varieties, to the housewife who finds better fruits and vegetables at her local market, made possible by the breeding of superior new strains. Between these two are the canners, the millers, the bakers, and the shippers, all of whom have had varieties bred to meet their specific requirements. As in the case of other lines of agricultural progress, John Public reaps the real harvest in the form of better living and lower costs.

"Streamlining" of cars may not have suggested the streamlined potato, yet such a variety is one of the chief goals of potato specialists everywhere. This streamlining is the elimination of deep eyes that cause such waste during peeling. Besides being more economical, the newer shallow-eyed varieties may be peeled with greater speed. Like the streamlining of cars, the elimination of deep eyes in potatoes is a gradual process. Our latest varieties are improvements, but still shallower eyes may be expected in later models.

Carrots used to be short chubby roots, far less attractive than the long slim beauties seen on many markets today. By careful breeding, a deeper orange color has been developed and the core has been made more tender or practically eliminated. The modern carrot, if well grown, has as little in common with the carrot of former years as a modern streamlined car with a pre-war gas buggy.

The shape of many vegetables has been altered for the sake of beauty or to fit modern needs. A new cucumber which is uniformly eight inches long, if properly grown, is ideal for the shipper. Small Hubbard squash to fit the modern kitchen have made their appearance on some markets. Appropriately enough, the variety is called Kitchenette. It is predicted that smaller varieties of watermelons better suited to the modern refrigerator will gain favor with the housewife as a logical successor to the 30-pound monsters so common in the past.

Nature decreed that certain plants should have barbs or spines either for purposes of protection or seed dissemination. Often those individuals with the sharpest weapons of defense were the

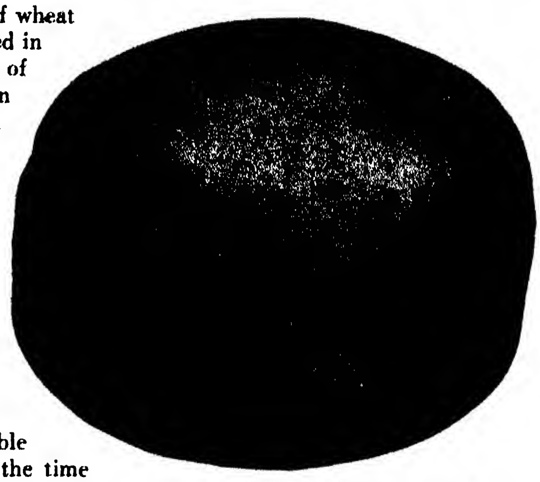
In soil badly infested with the fungus causing the yellows disease, the center row was planted to a variety of ordinary cabbage, the others to yellows-resistant types

ones best able to reproduce their kind; so, through natural selection, many species developed special means of protection prior to being cultivated by man. Just as Nature preserved individuals with the largest and sharpest weapons, man has, through many centuries of breeding, directed the process of evolution in the other direction. Wild plums and apples have thorns, yet our cultivated varieties of these fruits are entirely thornless. By selection through a number of generations, Luther Burbank once developed thornless cacti to be used as food for cattle. More recently another Californian has introduced a thornless dewberry—surely a boon to the berry picker. This streamlining for comfort has been extended to ornamentals. Many a gardener will rejoice to know that the plant breeder has taken the "barb" out of barberry, for a new "thornless" barberry was recently granted a United States Plant Patent.

OF the many plant improvements that add to the comfort of the grower perhaps none has had as enthusiastic acceptance as smooth-awned barley. In ordinary barley the awns, or beards as they are often called, are covered with tiny barbs. These slant backward from the tip of the awn like so many tiny fishhook barbs, and indeed their action is not unlike that of fishhooks as anyone who has threshed barley will tell you. Animals, too, suffer from eating these beards, for in many places barley is grown for hay. Many of our modern barley varieties are smooth-awned; that is, their beards, although still present, do not possess barbs. In wheat, the beards are not armed with such weapons, but the breeder has gone one step further by removing them altogether. Many of the best wheat varieties grown today are of the beardless type.

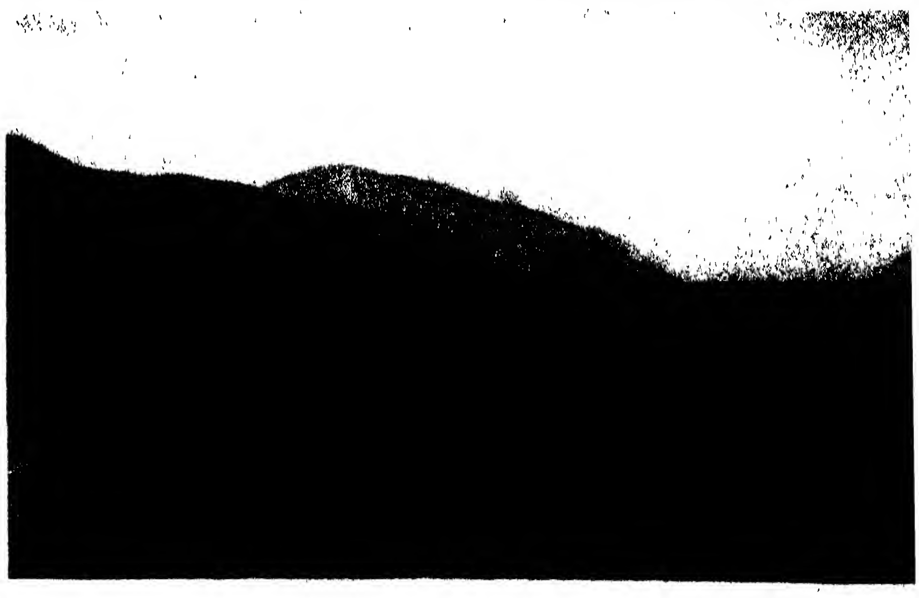
While working as a student assistant at a mid-western agricultural experiment station I was once assigned the task of cross-pollinating a number of wheat varieties. One day while engaged in making these crosses, a group of farmers on a tour of inspection happened to walk by the plot where I was bending over young heads of wheat which had just emerged from the sheath of leaves that protects them during their early development. The farm-crop specialist who was showing the group about stopped to tell them that I was making crosses and that the station hoped to breed a beardless wheat which also possessed certain other desirable characteristics. I was busy at the time cutting off the young beards with a pair of scissors prior to removing the pollen sacs and pollinating with a beardless variety. In making these crosses the beards are often removed merely because they are in the way. One old farmer remarked, "So that's the way you make 'em beardless." Unfortunately, it is not quite that simple, yet from the first beardless wheat discovered many years ago, breeders have, by cross-pollination methods, produced beardless varieties possessing other desirable characteristics such as high yield, disease resistance, and good milling quality.

The breeding of varieties of farm and garden plants that resist diseases has been one of the outstanding agricultural achievements of the 20th Century. Among the first serious plant diseases conquered in this way was the wilt of flax. At the turn of the century, flax growing in the north central states was becoming highly unprofitable due to the ravages of a soil fungus called *Fusarium lini.* All through the flax belt, "flax-sick" soil was being turned over to more profitable crops. The outlook for the domestic linseed-oil industry was anything but bright. Then a pioneer breeder, H. L. Bolley of the North Dakota Agricultural Experiment Station, saved



The new "streamlined" Chippewa potato. Absence of deep eyes reduces waste in peeling and also speeds up the job for the housewife

Below: **Stock seed blocks of peas growing in Idaho. Each strip is a different variety. Seed from them will go to large production fields where commercial seed is grown in quantity**



the day for both growers and processors by developing a variety that was highly resistant to the wilt organism. Bolley is ranked as a pioneer because he was probably the first man in the history of plant breeding to subject a crop to an artificial epidemic of a specific disease in order to determine which individuals possess hereditary resistance. This method, which is based on the principle of the survival of the fittest, is used by breeders everywhere today in their effort to control pests by superior heritage. Nor are they unaided in their efforts, for the plant pathologists work hand in hand with them, studying the disease organisms and learning how to induce epidemics at will.

There is scarcely a major crop that has not been saved from becoming unprofitable in some section of the United States by the breeding of disease-resistant varieties. Wheat rust, cotton wilt, and sugar-cane mosaic are a few of the most serious diseases conquered in this way. Recently sugar-beet specialists in the west have developed a strain of that crop which is resistant to the dreaded curly-top disease. Such streamlined, resistant varieties are now found in most every garden. Tomatoes and asters that escape their respective wilt diseases, and snap-dragons resistant to rust, are but a few of those listed in current seed catalogs.

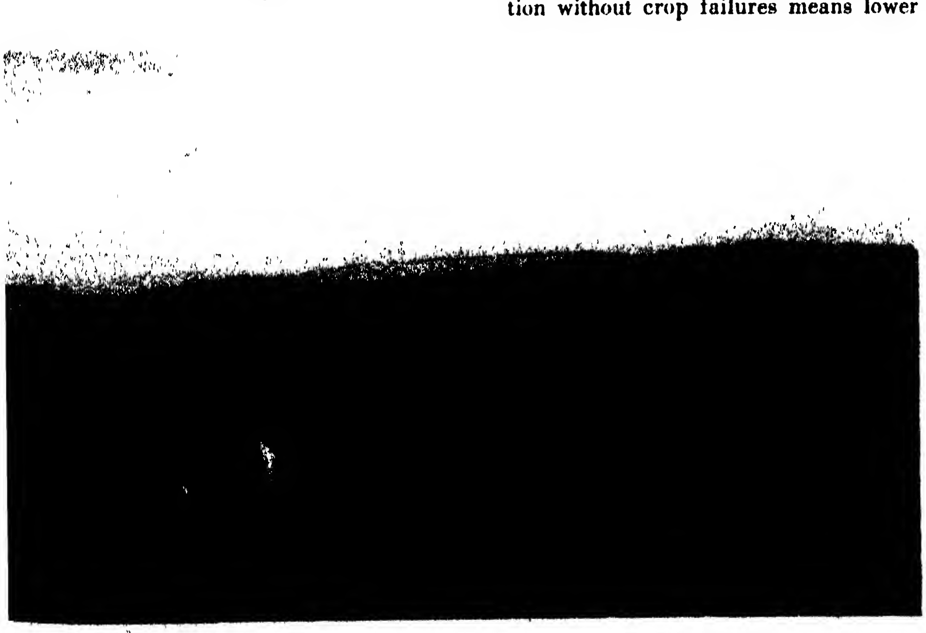
Evolution of petunias in the hands of the plant breeder. The one on the left is similar in size to the wild petunias. Note crinkly, attractive flowers of others

A striking result of plant breeding. At the left is shown a tobacco plant of the mosaic susceptible variety. At the right is another into which has been bred a resistance to this destructive disease of tobacco fields

John Public's dividend from disease-resistant varieties is probably greater than from any other plant-breeding accomplishment. Such varieties are perhaps doing more to stabilize agricultural production than all man's combined efforts along other lines. Stabilized production without crop failures means lower retail prices on farm products as well as a more prosperous agriculture. In a few cases, plants have been developed that resist certain insect pests. Great possibilities exist for further lowering of production costs and reducing the hazards of farming by the breeding of disease- and insect-resistant varieties.

I ONCE visited a cabbage grower who had a 10-acre field planted to an excellent strain of the Copenhagen Market variety. A large percentage of the heads in this field were ready to cut on the first harvest. Because they were so uniform in size and shape he sold the crop at a premium. Across the road was another large field of the same variety of cabbage planted by a man who was not so fortunate in securing a uniform strain from his seedsman. More than likely he saved a dollar or two on his seed, but what a loss this small saving caused! While his neighbor's crop was ready for harvesting within a period of 10 days, his harvesting dragged out for a month. True, his total yield was as great but the extra work involved in harvesting a dab at a time, together with the lower price paid for cabbage that varied considerably in size and shape of head, meant the difference between a good and a poor profit. The first grower was benefited by the work of a trained plant breeder in developing and maintaining a uniform strain of the Copenhagen Market variety.

Uniformity is one of the more important objectives of all plant breeders. A few wild-type peas in a canning variety may cause the grade and, likewise, the price of a whole pack to be lowered. That is one reason why canners and seedsmen employ breeding experts to maintain their varieties at a high level of purity. Uniformity is so important to the millers that grain shipments containing mixtures of certain types are sold at a substantially lower price. Some cotton mills are willing to pay a premium



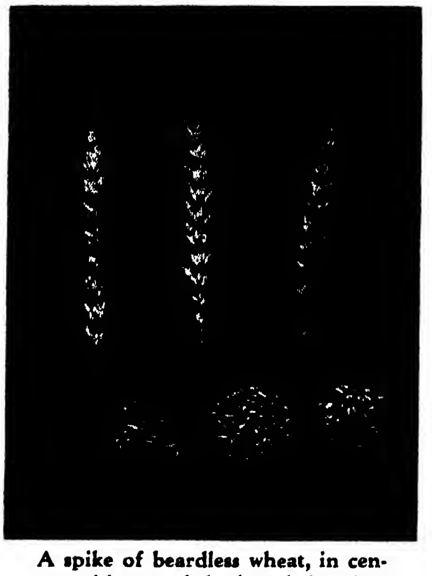
for staple of uniform length and quality. To supply this demand, certain areas have been set up as one-variety communities where only one specific variety may be grown and ginned. The reason for this is that cotton is naturally cross-pollinated and a uniform variety would be difficult to maintain were several varieties grown in neighboring fields as they ordinarily are. Breeders have developed high-quality, uniform strains of most agricultural crops but their job is never finished, because uniformity must be maintained by careful selection and seed-growing methods. Here, too, the breeders' efforts have resulted in better living for everyone through standardized and uniform quality in fruits and vegetables and other agricultural products.

IN 1857 Wendelin Grimm, a German farmer, moved with his family to Carver County in Central Minnesota. He brought with him a considerable quantity of alfalfa seed and the following year planted it on his new farm. Alfalfa had been grown in the east and, to some extent, on the west coast prior to that date, but it was not hardy enough to stand the long cold winters of the north. Grimm's first plantings suffered from winter injury but always a few plants survived; the persistent German immigrant determined to grow this valuable forage crop in his new home, and saved seed year after year. It is improbable Grimm thought of himself as a plant breeder, yet by growing the progeny of these super-hardy plants singled out by natural selection he founded a strain which was destined to extend the alfalfa-growing region hundreds of miles northward. It is fitting that this strain is known today as Grimm alfalfa.

Greater winter-hardiness has been one of the important contributions of breeders to agriculture in northern climates. Using natural selection as their most useful tool they have developed hardier varieties of wheat and rye that have extended the winter grain belt northward, making it possible for more farmers to take advantage of the desirable practice of fall planting. Plums, apples, and other fruits now enrich the farm life in areas formerly considered far too cold for successful cultivation of these valuable species.

Soon after the development of the quick-freezing method of preserving fruits and vegetables it was found that certain varieties were far better adapted to this process than others. For example, a pea variety to be well adapted to freezing preservation must develop a brilliant green color during the process of blanching and freezing, and this color must remain during the period of storage. At the same time it must not develop undesirable flavors. A tendency to split eliminates it entirely from the list of useful varieties for quick freezing. Not all otherwise good pea varieties come up to these standards. Today, with frozen fruits and vegetables growing more popular by leaps and bounds, breeders are paying more and more attention to the adaptability of varieties to this new and expanding method of food preservation.

Oil-producing plants such as flax and



A spike of beardless wheat, in center, with two of the bearded variety

soybeans have been bred not only for high oil content but for a quick-drying type of oil more useful to the paint manufacturer. These hereditary changes in the drying properties of plant oils are but one example among many in which the chemical nature of plant products has been altered by the breeder. High nicotine content in tobacco grown for nicotine extraction, pyrethrum flowers that will give a high yield of the extract used so extensively in insecticides, poppy varieties that produce large quantities of opium; such are the achievements of the breeder in increasing the efficiency of drug-producing plants.

New early- and late-maturing varieties have extended the season through which many fruits and vegetables may be had at reasonable prices. Other early varieties have enabled growers in northern climates to utilize certain crops which were formerly grown only in areas with longer seasons. Varieties with erect habits of growth for machine harvesting, grains with stiff stems that resist damage from beating rains, and corn that will yield fairly well in spite of dry weather are recent plant-breeding accomplishments that make farming more profitable.

Nowhere is the work of the plant breeder more conspicuous than in the flower garden. Without the closest observation, who would recognize the kinship between many of our lovely garden flowers and the relatively unattractive wild species from which they arose? Not only in showy beauty but also in scent have many garden plants been glorified. One of the most recent contributions to the home garden is a marigold whose leaves lack the usual pungent odor so distasteful to many who would otherwise number this species among their most favored flowers. Several varieties of marigolds with this desirable characteristic are now available from many seedsmen.

High yield and quality are desirable characteristics in any variety. These two factors must be considered in determining the value of new strains, in addition to their other desirable attributes. With crops grown for some purposes such as feed for livestock, yield is the most important factor; but in fruits and vegetables, higher and higher quality is the progressive goal of those who breed these plants. To be sure, any variety must yield reasonably well to be accepted by the grower, but without quality to satisfy some specific demand, the highest yielding horticultural crop would be of little value.

THE ability to yield is a complex attribute dependent on the inherent vigor of the plant, adaptability to specific environmental conditions, resistance to disease, and many other factors, but quality is perhaps even more complex. Every accepted variety considered of good quality has dozens of specific and interrelated characteristics that raise it above the hereditary level of certain other varieties within the species. Quality in plants and plant products is as impossible to define as intelligence or beauty in animals.

Color, flavor, odor, and keeping ability are but a few of the quality factors considered in selecting superior individual plants or varieties in horticultural crops. Cooking tests, canning tests, and tests for vitamin content are examples of the special techniques that must be employed by many breeders. In addition to a knowledge of breeding methods and the related sciences every breeder must know the plants with which he is working. An understanding of marketing methods and demands, of canning and preserving processes, and of the desires and whims of the housewife is absolutely essential if one is to develop new plants that will fit into the highly complex agricultural picture of a streamlined age.

The job of the plant breeder is unending. As ways of living change and new methods of processing plant products develop, demands for new varieties continually arise. Changes in soil fertility, changes in diseases and insect pests, and changes in farming practice require a plant-breeding profession ever ready to mold the plastic plant material, with which Nature endowed us, to fit existing and future needs.

OUR POINT OF VIEW

Better Naval Defense

NO one except Navy officials, a few Congressmen, and the White House knows, as this is being written, just what naval construction and expansion will be planned and authorized during this session of Congress. That there will be a definite, rather sizable expansion is conceded to be not only desirable but urgent. The belligerency of certain other nations is responsible.

The *Panay* incident, senseless and idiotic as it was for the attackers, and tragic as it was for the attacked, holds the promise of being of vast benefit to the world. It has awakened the American public out of its complacency and shown us that unless we expect to throw up an insurmountable wall around our borders we must be prepared to demand complete protection for our citizens throughout the world. It has proved that, as many people have long contended, we do not really want to maintain this sort of indifference, that we want a return to the traditional principle that our flag must be respected wherever flown. It has ranged on the side of the democracies and weaker nations—more definitely than for a long time—the voice of America which can and will be strong once more. But while it is not likely that we will enter into any foreign commitments—officially—the temper of the nation is such that the war makers will charily watch every defense move we make. Our moral support can be a powerful factor in the preservation of peace.

At present, strengthening of our "first line of defense," the Navy, seems assured. After years of abortive attempts to achieve a real naval limitations agreement among the nations, we have been slow to accept the inevitable. Not content to let our early "disarmament by example" betoken our sincerity, we still adhered to the letter of our various naval treaties after their expiration and even entered into a further one with Britain and France. The "escape clause" in this last one, however, gives us the necessary opportunity to call the bluff of a belligerent world. Present indications are that our naval-building program, soon to be inaugurated, will be larger than at any time since the days immediately succeeding the World War.

Unless forced to do so, however, we will launch no very extravagant program of ship-building. In no case will we make unjust demands of any nation, nor will we use our Navy in any aggression. But the naval construction which is detailed in the Digest of this issue will certainly be expanded. If necessity arises that expansion will be great.

Out of the *Panay* incident comes strong assurance from another quarter that Americans are about the same as they always have been. They are no more pacifistic, nor more war-like than they were before the World War, nor will they take insults with any better humor. This journal predicted editorially in 1934, when students all over the land were signing the pledge never to fight for their country, that they were simply allowing emotion—adolescent hysteria—to rule them; and, further, that as they matured or emergencies arose, they would be among the first to renounce pacifism. It has happened! A group representing a student organization in a convention at Vassar last Christmas vociferously renounced their "I won't fight" pledges.

That editorial was based upon a first-hand knowledge of the fundamental character of the American people. We would advise the trouble-makers of the world to get a whale of a lot of such knowledge before they try our temper too much.

New Methods, New Puzzles

THE history of science and industry includes many examples of the fact that very often one problem cannot be tackled until another has been quite solved. One such example is the fact that the Panama Canal could not be dug until medical science had learned about the mosquito as the source of yellow fever. Similarly, until yesterday, the geologists, though possessing fairly detailed knowledge of the strata and topography of the land surfaces of the globe, still could not satisfactorily deal with the ocean bed, a full three fourths of the earth's surface, because the relatively few and scattered soundings taken over its vast expanse gave only a generalized picture of the hidden shapes beneath the waters. It was sometimes suspected, however, that if the oceans could only be unwatered to permit a full view, a surprising variety of shapes would be revealed.

Relatively recently, with the perfection of the sonic depth finder installed in ships' bottoms, this surprise has taken place. In a few regions the United States Coast and Geodetic Survey ships have now attempted and successfully made detailed submarine maps by this method, and have developed the technique until it is comparably accurate with land topographic surveying. To geologists and all scientific persons there is the same thrill in this happy accomplishment as there is in falling heir to a small fortune which one never hoped to see.

One of the by-products of this method has been the precise mapping of submarine canyons off the coasts, notably the one that lies some 100 miles off the harbor of New York and which is comparable in depth with the Grand Canyon. The slopes of this vast chasm have been mapped in accurate and fine detail and from these submarine contour maps we see the various shapes of the sub-seascape just as we see that of our familiar high-and-dry landscapes on looking at maps of the same kind. An area similarly mapped near the Alaska Peninsula reveals in detail the topography of familiar landscapes.

The solution of the great puzzle—what excavated the canyons?—is likely to keep geologists intrigued for years to come. What agency could excavate a canyon a mile deep in the seabed, under water? Perhaps, however, the canyons were excavated when the seabed was above water. Have the ocean beds been lifted above water, deeply eroded by streams and then let sink again? Or did the great ice caps of the Pleistocene glacial epoch withdraw enough water from the ocean basins to permit erosion on the land thus made naked? If so, much more water was locked up in the polar ice than glaciologists have previously believed. Could submarine currents have excavated these canyons in solid rock? Among geologists, several other hypotheses, some of them rather abstruse, have been offered and studied, but the answer has not yet been revealed.

In other ways geologists are becoming intimate with the hitherto standoffish seabottoms. C. H. Piggot has developed a technique for taking more satisfactory samples of them than any we have had. He lowers a kind of gun into contact with the bottom and then fires it, shooting a tubular sampler some distance into the silt and bringing up tale-telling sections representing very long periods of slow deposition. A new way to measure the thickness of strata below the waters by means of artificial explosions—a special application of the seismographical prospecting now well-known because of its use in the search for oil on land—is also coming into use.

In short, the forbidden, mysterious ocean beds are now surrendering some of their mysteries. Ways to accomplish the impossible are being found. Once more the impossible is becoming possible: soon may become commonplace.

ENZYMES: KEYS TO

At the Forefront of the Scientific Stage Today Are These Important Controlling Substances on Which Highly Significant Researches Are Being Conducted

UNTIL 1895, a mystic "vital force" was thought to be the secret behind many a stimulating and regulating activity of protoplasm, the subtance of life. Thus, this vital force was considered to be the cause of yeast's power to change or ferment sugar into alcohol and carbon dioxide. The vital force, scientists guessed, vanished when the yeast died. But in 1895, Büchner ground yeast with sand —of course killing the organisms—and then proved that the non-living extract which he obtained could still cause fermentation, even though no ghost was haunting the reaction.

En-zyme—Greek for "in yeast"—was the name given the ferment, or active part of the yeast's juice, and is the name applied today to scores of similiarly active substances which cause, accelerate, and control biochemical reactions, no matter what the species of animal or plant.

Life's darkest, most fascinating secrets are hidden in the mysteries of enzymes—now known to be huge and intricate molecules, somehow able to dominate the uncountable chemical activities within living flesh.

Only because of the play of enzymes can we digest our foods, or find chemical value in our very breath. And the use of food and oxygen in the multivaried events of growth, movement, reproduction, and even sensation and our thoughts—all is unlocked by these really miraculous keys.

THE genes which control inheritance are seemingly no more and no less than enzymes. Germs of tuberculosis, leprosy, plague—of all infections—can attack and injure us only because they pour out enzymes having deadly effect upon the chemistry of our life substance. The virus—a germ minute beyond the powers of the microscope, and the cause of infantile paralysis, influenza, and smallpox—may be simply pure enzyme, and nothing else besides: a sort of parasitic molecule.

Cancer—not a germ-disease—is the guilt of the body's own distraught dictators, which have become over-stimulating to the multiplication of useless cells, at the horrible expense of other tissues. Phages, odd ultra-microscopic bits of matter which devour bacteria, must also be varieties of enzymes—perhaps produced by unhealthy bacteria themselves.

And now substances, inductors or organizers, have been discovered by Hans Spemann, of the University of Freiburg, Germany. Inductors, found in very young animals or embryos, guide the formation of organs out of simple, formless masses of cells and thus induce eye, kidney, brain and every organ to take shape. These organ-inducing substances, though not yet extracted pure and still little known, are also widely believed to be kinds of enzymes.

Finally, since enzymes control all the chemical reactions which together mean life, they are responsible for those lethal developments in every higher creature: the phenomena of aging that end in natural death. Hence, full knowledge of enzymes means knowledge of the most important problems of bio-science and experimental medicine.

Photo Science Service

Prof. Hans Spemann, discoverer of inductors — organ traffic police

In all, surely there are myriads of enzymes, since no activity of protoplasm is conceivable in their absence. Oxidases are enzymes effecting the oxidation or burning of fuel foods for energy's sake. They may be seen in action when an apple or a potato is cut. In the presence of air or oxygen, they oxidize colorless compounds of the exposed tissue to dark-colored ones.

Pepsin, of the stomach's gastric juice, splits unwieldy proteins into simpler molecules, which other enzymes continue to digest or crack until fragments useful to the tissues are reached. Trypsin of pancreatic juice helps in this protein-bursting labor. Fats are exploded by lipases, and starches by amylases, such as saliva's ptyalin, which makes sugar out of starch.

Thrombin aids blood to clot. It is lacking in hemophiles—bleeders. Negroes are dark because of the enzyme tyrosinase. Tyrosin is a colorless substance present in most skin. When tyrosin is oxidized by tyrosinase, it turns black. An albino lacks the enzyme: hence cannot become pigmented.

Thus enzyme actions are chemical actions. Enzymes produce chemical changes, altering one molecule into another. Most of such alterations, all essential to animate existence, would not occur without enzymes. Other alterations in molecules, unless influenced by the stimulating presence of enzymes, would take place at too slow a pace for life's needs. Still other molecular changes would not be possible at life's moderate temperatures—or in life's tiniest laboratories, the cells—or with life's required efficiency. In his scientific laboratories, man discovers it impossible to duplicate these enzyme-caused chemical activities without powerful and poisonous reagents, life-destroying heat, complicated and bulky apparatus, and high inefficiency. Man's respect for the enzyme is therefore great. Man would learn from the enzyme many a means to cheap manufacture of invaluable products.

THE firefly and deep-sea monsters can boast of practical use of "cold light," thanks to the enzyme luciferase. This molecule acts upon a mysterious substance, luciferin, present in luminous organs, and the result is light almost without heat. Here, as indeed in every instance of enzyme marvels, the enigma of the biologist becomes the enigma of the chemist and the physicist too. What is the basic nature of enzyme activity? What is the fundamental mechanism by which enzymes are able to regulate—to dictate—the work of other molecules? As to the theory of enzyme machinery, there is as yet only one point of agreement: Many stupendous scientific problems are concerned—biological, chemical, and physical. Exceeding bafflement is as yet the sole reward of those who have spent and those who are spending their careers in the attempt to elucidate the movements and the chemical changes of an enzyme molecule as it busies itself with a life task. When will man have cold light in his dwellings? This will

LIFE AND DEATH

By BARCLAY MOON NEWMAN

be when research has described something of the comings and goings of certain remarkable little things—such as luciferase's secretive linkage of atoms.

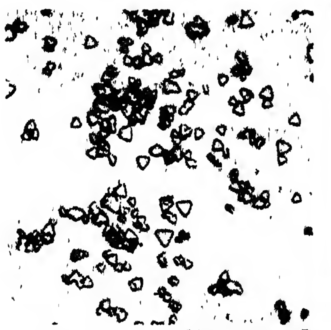
So all scientists are today intensely interested in these activators of vital processes. The chemist sees that they are vast collections of atoms, often thousands of atoms, united into molecules of really unique size, weight, and complexity.

Chemical analysis shows that the atoms involved are the typical life-givers: carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, and several metals, including at times iron and magnesium.

Such great aggregations of atoms belong to the mighty class of compounds, the proteins, discoverable only in living things or their products. Their intricacy promises long to be the despair of the constructor of formulas. Laboratory synthesis of any protein, any enzyme, will transcend human skill for many years, perhaps many decades—some pessimists say forever. Meanwhile, enzyme-synthesis remains the first step in creating life in the test tube.

THESE gigantic gangs of atoms are exceedingly delicate. They are readily affected by the slightest chemical or physical influence. Boiling destroys them, often coagulating them just as it does the protein *albumin*, main constituent of egg-white, making them insoluble and precipitating their particles like snow to the bottom of the solution. Probably all laboratory reagents alter them somewhat, usually transforming them into wholly different compounds, as by bursting them into their component parts. Therefore it was for a long time impossible to isolate any of them unchanged and in pure form from living tissue. It was averred by numerous experts that no enzyme would ever be obtained in crystalline, that is, chemically pure, state. And as long as pure enzymes were unavailable, little could be learned of their structure and of the machinery of their action on bio-chemical compounds either in protoplasm or in laboratory ware.

At last, in 1926, Dr. James B. Sumner won the honor of being the first to secure an enzyme, urease, as crystals of an uncontaminated compound, and one precisely like that naturally occurring in the protoplasm used as a source. More recently, Dr. John H. Northrop, of the Rockefeller Institute, has achieved the crystallization not only of pure pepsin, from the cow's gastric juice, but also pure trypsin, from pancreatic juice of the cow too—both enzymes being protein-splitters, and Dr. Henry C. Sherman, of Columbia University, has forced amylase, a starch-digester, into the symmetry of the pure state. Quite definitely, Americans are far in the van of this special scientific endeavor: indeed, so far in the lead that a number of European investigators are still blind to the fact that Sumner, Northrop, and Sherman have indubitably secured true, uncontaminated enzyme-molecules. Such doubts are, however, perhaps natural in view of the incomparable intricacy of enzymes and of the mechanism of their action.



Photos courtesy Drs. Northrop and Kunitz

Left: **Trypsin crystals. Each crystal is made up of many molecules of trypsin, a digestive ferment (enzyme) which breaks down proteins into simpler molecules. Trypsin is produced by the pancreas, whence it travels into the small intestine, there to carry on its activity. It was first obtained in its pure, crystalline form by Drs. John H. Northrop and M. Kunitz.** ***Right:*** **Trypsinogen, from which trypsin is formed, isolated by Drs. J. H. Northrop and M. Kunitz, Rockefeller Institute**

Nevertheless, doubts are now being rapidly dissipated and our knowledge of these amazing molecules and their kin is accumulating apace—mainly because of the invention of the ultra-centrifuge, new marvel of the biologists and chemists who are mindful of physical chemistry, as all good scientists must be today. This instrument [Scientific American, June 1936, page 329—*Ed.*], though merely a high development of the principle of the cream-separator, is literally whirling out profound secrets of creation's biggest molecules, proteins.

Thé Svedberg, renowned Swedish scientist and Nobel-prize recipient, who has had preëminent success in applying the technique of physical chemistry to the study of complex bio-chemical compounds, pioneered in research with the ultra-centrifuge. About 13 years ago, he invented the first high-speed centrifuge, an oil-driven machine.

The solution holding the substance to be analyzed is put into tiny quartz tubes fixed horizontally within a rotor of special alloy and special shape. The rotor is spun by means of a high-pressure oil-jet striking the blades of a turbine. In order that friction and heating may be reduced, the rotor spins within a partial vacuum containing hydrogen instead of air. The apparatus must be cooled by streaming oil, since the rotor is made to yield speeds as high as 75,000 revolutions per minute: of course with the production of considerable heat. Higher velocities are possible, but the tremendous centrifugal force developed—more than 500,000 times the force of gravity—is likely to explode the rotor.

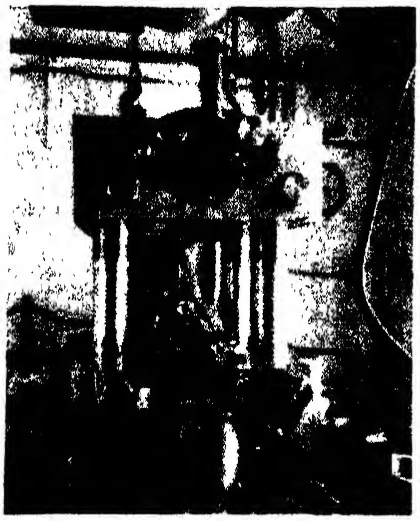
THE specimen is observed even while being whirled around at 1000 times, and more, per second. Svedberg accomplishes this feat by passing a beam of ultra-violet light through the transparent tubes containing the specimen. The beam undergoes a certain amount of absorption and scattering, depending upon the size of the molecules and upon the degree of clumping of these particles as they are urged toward the outer ends of the tubes by the mighty centrifugal force. The changes in the ultra-violet beam are caught and recorded by means of a photo-electric cell.

In the ultra-centrifuge, as in any centrifugal separator, the heavier the particles, the greater is the rate at which they are flung outward. Therefore the weight of the protein or other bits in the specimen solution can readily be determined from the rate at which they are flung outward, or sedimented, within the tubes.

Never before had any one been able to measure proteins in so direct a way. And until Svedberg's investigations, great uncertainty beclouded the best estimates of protein molecular weights, sizes, and shapes—even though accuracy here is the prime essential to any real understanding of the chemical and

physical nature of these meaningful compounds. With his invention, Svedberg made a remarkable series of highly precise measurements upon many proteins. Besides, since he used physical methods, his determinations applied to pure and unchanged proteins—whose extreme delicacy chemical methods so swiftly and sadly disrupt.

Svedberg's researches have proved that the weights of protein molecules gradually scale up from 34,500, the weight of hemoglobin, the pigment and oxygen-carrier of human blood, to 5,000,000, the weight of hemocyanin, the pigment of the blood of the snail, *Helix pomatia*. The giantism of such collections of atoms may be emphasized by comparing their molecular weights with that of hydrogen gas: merely 2. Other molecular weights for comparison are: water, 18; sodium chloride or table salt, 59; and cane sugar, 342. The actually stupefying intricacy of protein molecules is indicated by the fact that, as familiar and fairly well understood molecules go, cane sugar is generally regarded as complex—and for scores of years chemists were not even able to write its formula. Further, cane sugar is a cluster of a mere 45 atoms; certain proteins are clusters of *several thousand* atoms to the molecule.



The Svedberg ultra-centrifuge at the duPont Experimental Station. Upper part is removed, revealing rotor and cell for the solution

DEVELOPMENT of the air-driven centrifuge in the United States—the one just described being oil-driven—especially by Beams of the University of Virginia and McBain, of Stanford University, is leading to still more significant findings. The air-driven machine has two important advantages. It is inexpensive (no one but Svedberg could afford the oil-driven device, requiring the most expensive of parts and, too, a whole corps of highly trained mechanicians to nurse it along) and large volumes of liquids can be centrifuged in the air-driven 'fuge, instead of only a few drops, as in Svedberg's invention. Also, its velocity is limited only by the strength of the rotor: one rotor made of the alloy duralumin exploded when spun just above 2200 revolutions per second (132,000 per minute).

Dr. Ralph Wyckoff, of the Rockefeller Institute, has been using the air-driven ultra-centrifuge to swirl out knowledge of viruses. He has determined that the typical virus of the mosaic disease of tobacco has a molecular weight of about 17,000,000—more than three times the weight of Svedberg's largest specimen. Moreover, his work with this and other viruses of both animals and plants seems to be establishing a most interesting point: While other proteins are wondrously big and heavy, viruses are the biggest and heaviest of all—no other molecules remotely approach the size of the virus architecture. Hence, he is now asking the question: "Can molecules the size of virus proteins occur naturally in plants and animals without producing disease?"

INDEED, it is becoming more and more evident that when we get enzymes as big as viruses, and when these get into living protoplasm, they astonishingly take over the whole economy of the victim and govern it to their own morbid advantage. For instance, a trace of virus enters the tobacco plant, oddly is able to assume control of the life processes, and actually transforms the major part of the host's vital substance into hordes of virus molecules. This phenomenon is among the most remarkable ever brought to light in the entire history of science. Is it possible, besides, that the virus-germs of the great virus plagues of ancient and modern history—smallpox, influenza, encephalitis, and the common cold, greatest of all plagues in total economic loss, arose not outside man but, astonishingly enough, within man himself—just as the phages are supposed to leap from malfunctioning enzymes within bacteria and then destroy that which gave them birth?

The mechanism of how a single, presumably non-living molecule turns living stuff totally unlike itself into many million copies of itself cannot yet be even imagined. Nevertheless, though on a much grander scale, this mechanism can be fundamentally no different from the activity of lesser enzymes. A gene, probably an enzyme of molecular weight 50,000 (merely), creates a duplicate of itself out of the surrounding life-fluid every time a cell divides in two—that is, reproduces. By this means these determiners of heredity—parent-derived regulators of hair-color, size of body, shape of face—are able to be a portion of every cell in the body, and so help to mold the young tissues into the inherited adult form and adult behavior.

Enzymes can perform in other ways almost equally strange. Pepsinogen is the parent-molecule, as it were, of pepsin. It is similar to pepsin in chemical structure, but cannot digest proteins. In the presence of hydrochloric acid, supplied by gastric juice, pepsinogen transmutes itself into pepsin, "more alive" and able to split proteins into their components. Here is an enzyme producing itself—practically spontaneously—out of unlike material.

Enzymes also attack and digest other enzymes. Pepsin solution cannot be kept long exposed to the air. Bacteria fall from the air into the solution and exude their own enzymes, which break down the pepsin into fragments which the bacteria absorb for food.

Wyckoff has recently called attention to other and highly practical aspects of enzyme and virus activity. Just as pepsinogen, only an atom or two different from pepsin, is inactive, and "harmless" to proteins, so displacements of a mere atom or two within a virus mean the difference between a diabolically efficient destroyer of animal flesh and a helpful stimulant to the body's resistance—to an attack of the active, unchanged virus. Everyone today benefits from this phenomenon—smallpox vaccine is human smallpox virus, only very, very slightly altered chemically, though greatly weakened biologically and medically, by its culture in the cow. It has been transmuted, by its sojourn in the cow's chemical system, from "human pox" into "cowpox." And the human body finds this slightly changed virus a most valuable stimulus to smallpox immunity. So immunity follows vaccination with cowpox.

Photos courtesy Drs. Northrop and Herriot

Left: **Crystals of pepsin found in gastric juice of the stomach and first isolated by Northrop.** ***Right:*** **Pepsinogen, forerunner of pepsin**

The centrifuge is being made still more helpful—here helpful in inducing such slight changes in viruses. Here we have molecules larger by far than Svedberg's earlier interests—and far more fragile, hence far more susceptible to breakage upon being whirled by the swift-cycling 'fuge. Thus, Wyckoff and his associates are already noting differences in viruses' virulence, or infecting power, according to the amount of jarring provided in the centrifuging. We are definitely on a new road, perhaps even a royal road, to conquest of man's evilest afflictions and life's mystery.

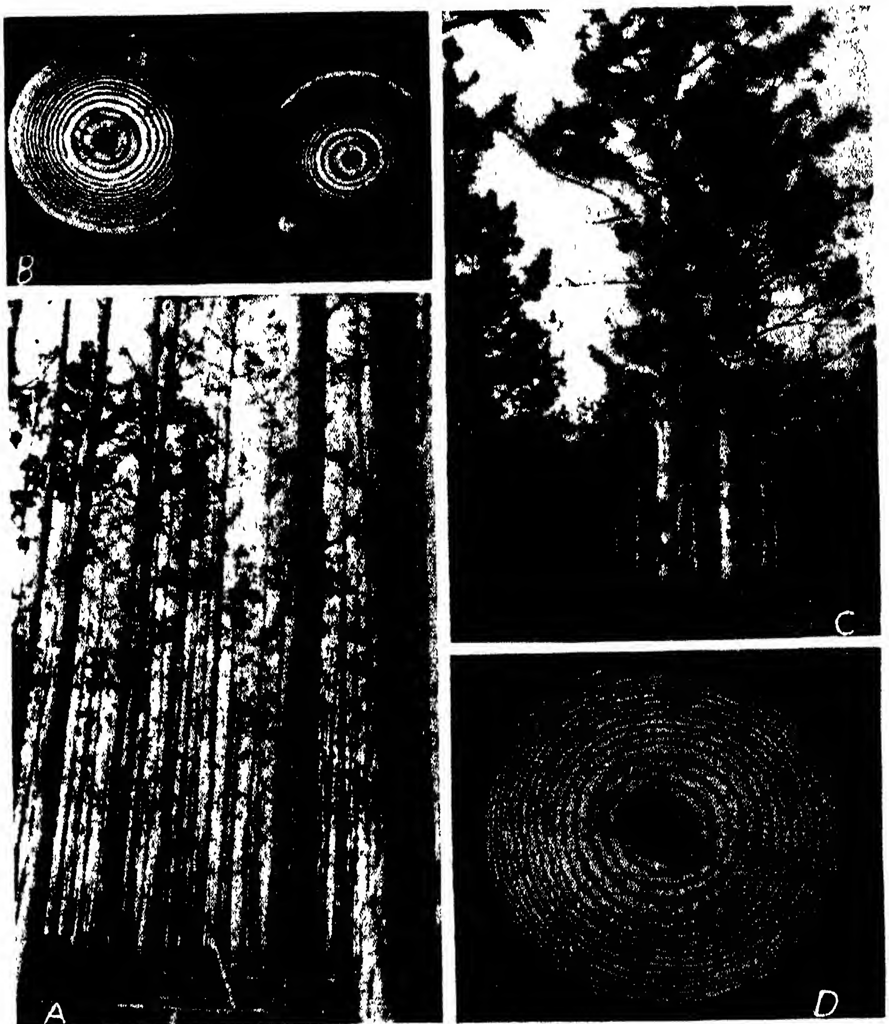
Wood Grown to Order

MEANS of controlling the strength or weakness, hardness or softness, of wood which forest trees will produce in the next 50 or 60 years has recently been achieved. No longer is the future of all American woods placed in the lap of Nature with a fervent hope that she will produce the type of wood which man's more exacting uses require. From now on, a check rein may be held on Nature's caprices—and caprices they are, when she produces, in the same species of tree, wood of widely varying qualities.

Until recently, however, there has been no difficulty in securing in this country, whenever needed, wood having the properties desired for a special use. But now that the virgin forests are disappearing, the nation's troubles are about to begin as it becomes necessary to depend more and more upon the younger, second-growth stands with their smaller trees containing a lesser relative amount of high quality lumber. Consequently, to learn how growth conditions affect or control the quality of wood has become of such major importance that for the past 14 years the United States Forest Products Laboratory, Madison, Wisconsin, has been investigating the subject. To Benson H. Paul, laboratory silviculturist, fell a large share of the responsibility.

ONE phase of the many-sided study has been the application of silviculture in controlling the specific gravity of wood, which previous studies proved is a fair basis for judging its strength, hardness, and other physical properties.

It has been shown beyond a doubt that severe crowding in the broad-leaved species studied causes a decrease in the specific gravity, and therefore in the strength, of the wood produced. By relieving the crowded conditions in which the trees grow, specific gravity will be increased and the wood will be stronger. It is also apparent that wood having the most uniform strength and fewest defects is produced, in the hardwoods, when the young trees are grown sufficiently close together to cause dying and removal of side branches by exclusion of sunlight, and are thinned later to provide for faster growth in diameter. If fairly rapid growth is sustained by keeping the trees properly thinned, crops such as ash and hickory will mature in the comparatively short period of 50 to 60 years, instead of the usual 100 to 150 years.



Longleaf pine stand A will produce dense wood (cross-section at B); stand C, of broad crowned trees, will produce relatively low density wood, as shown at D

By MARY BRANDEL HOPKINS

In the cone-bearing southern pines and redwood, control of specific gravity through the influence of growing space calls for somewhat different treatment.

In these species, strength depends principally on the relative proportions of the weaker springwood and the heavier summerwood in the annual growth rings. In second growth forests, spacing of trees has a distinct influence, the springwood portion being much narrower in the small-crowned trees of crowded stands, the amount of summerwood proportionately greater, and the wood accordingly heavier. But the crowded trees grew slower than those in more open stands. Thus in coniferous species the production of timber of very high strength requires a longer time than that having lower strength.

On the other hand, relatively wide spacing of second-growth southern pines and redwood throughout the entire period of growth will give the trees larger crowns, more knots, and a higher percentage of light wood. But offsetting this disadvantage is the possibility of growing a tree of specified diameter in much shorter time than would otherwise be required.

Because quantity and quality production are evidently combined on the more fertile forest sites, prevention of forest fires, the basis of soil improvement, will go a long way toward improving the quality of the wood grown. If no forest fires occur, the organic content of the soil will increase; decomposition will furnish it with nitrogen; moisture will be retained. The result will be to increase the production of strong summerwood.

NEW ASTRONOMICAL ADVANCES

A Résumé of Some of the Researches Described at the Most Recent Semi-Annual Meeting of the 400 Astronomers of the North American Continent

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington.

THE meetings of the American Astronomical Society are always enjoyable affairs, for the astronomers of this country are friendly folks, and not too numerous to be included in a single circle of acquaintance, nor to overstrain the accommodations available in a small town. This makes it possible to meet usually at some college or university, and be together not merely during the formal sessions, but for the whole time—to great mutual advantage.

The recent gathering in the western university town where these lines are written has been a fine example of the success of this policy—with a cordial welcome, an exceptionally attractive place of meeting, and a long program of good papers. The only fear which might have been felt in advance was that there might not be time for presentation of them all; but this was dispelled by a general spirit of co-operation, assisted by a dark-room "interval timer," which could be set to the exact time alloted to the paper on the program, and which rang a perfectly audible signal at its conclusion!

The 50 papers which were presented to the Society covered a wide range, from gravitational theory to the details of instrumental construction, and from the moon to remote regions of the galaxy.

Beginning with theory, we may note the work of K. P. Williams of Indiana on the transits of Mercury. It has long been known that the observed times of these, like the observations of the moon, indicate that something is wrong with the earth's rotation as a time-keeper. The records of ancient eclipses of the moon and sun show that the earth is very gradually slowing down, doubtless due to the cumulative effects of the friction of the tides; and the observations of the last two centuries exhibit irregular fluctuations after the effects of all known forces which act on the moon, including the tidal friction, have been allowed for, which it is now generally recognized must be due to irregular, and so far unpredictable, changes in the earth's rotation.

Williams, applying the corrections for the latter changes deduced by Spencer Jones, finds that they greatly improve the agreement between calculation and observation, but leave outstanding a slow, steady change. Mercury is gradually running ahead of the calculations, just as would happen if the days, which we assume to be of equal length, were slowly getting longer. The rate of this change appears at first sight to be about 2½ times as great as is found from observations of the moon. But it is well known that tidal friction reacts on the moon, forcing it farther from the earth and lengthening its period. When allowance is made for this, the observations of Mercury and of the moon are found to be in entire agreement. The irregular fluctuations (which during the last century have at one time made the earth 15 seconds slow, compared with a perfect clock, and at another 15 seconds fast) affect Mercury and the moon in just the same way, showing that they must arise from some cause in the earth alone, without reaction on the moon. Brown's explanation by minute changes in our planet's diameter, due to some internal forces, is thus confirmed.

WHAT care is taken with the observations of the moon is well illustrated by a communication from Watts, Whittaker, and Adams of the Naval Observatory. They have corrected the meridian observations of the time at which the moon's limb crosses the wires of the transit circle to allow for the fact that the observed point on the moon's edge is sometimes on the top of a mountain-mass, and at others in a low-lying place, and they find that the agreement of the observations is decidedly improved. For several years past, the earth's rotation appears to have been quite uniform—that is, there have been no internal changes affecting its diameter by more than an inch or two.

An interesting paper upon the planets came from E. C. Slipher of the Lowell Observatory, who sent on some fine slides of photographs of Mars, Jupiter, and Saturn, taken with light of many different wavelengths, from the violet to the near infra-red. Jupiter's atmosphere, above his cloudy surface, was remarkably transparent—sharp details being visible right up to the limb. For Mars, the well-known permanent markings, though easily photographed with red or yellow light, cannot be observed at all in the blue. It has often been suggested that this arises simply from their color—the reddish surface of the planet reflecting much more red light than the gray or greenish markings, but almost the same percentage of the blue rays. But, last May, a series of photographs taken with blue light showed the Syrtis Major—one of the most prominent of the permanent markings—distinctly, for several days. A few weeks earlier and later, only the general nondescript appearance was found on the "blue" pictures, while those with the red screen showed that the markings had been there all the time.

This shows beyond a doubt that the Martian atmosphere is usually filled with a blue haze so dense as to obscure the surface (so long as only blue light is used), while for a few days last May the haze cleared off over millions of square miles and for once revealed what lay below.

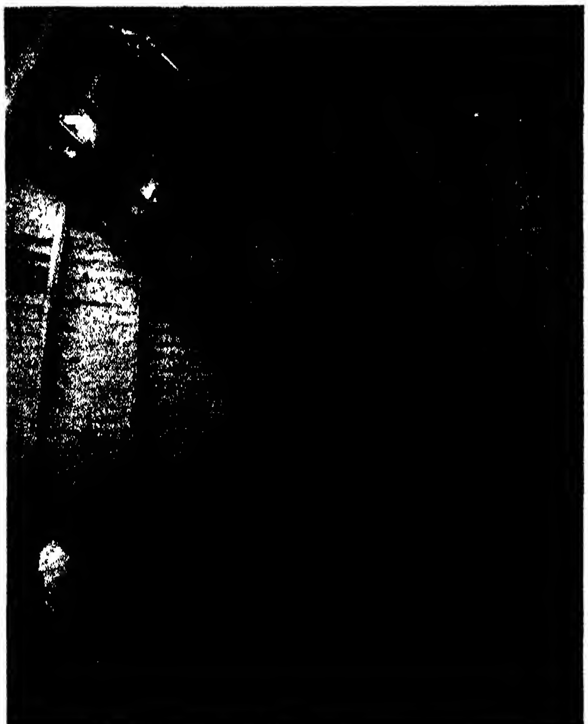
What causes this peculiar haze no one yet knows; it presents a tempting problem to the investigator. But we know more of the earth's atmosphere than we did before two other observers from Flagstaff, Adel and Lampland, reported (at the American Association meeting at Indianapolis) the discovery of nitrogen pentoxide (N_2O_5). This was decisively identified by an absorption band far out in the infra-red, where observations can be made only with a bolometer. This highly reactive compound is produced, like ozone, by photo-chemical reactions, high up above the stratosphere, and is not found near the earth's surface.

Whipple at Harvard reported on meteor trails picked up during the "sky patrol" work at Cambridge and Oak Ridge. These plates are taken every clear night to keep track of the stars in general, and afford a permanent record of what goes on in the heavens. Once in about a hundred hours of exposure time a meteor bright enough to leave a photographic record flashes across the field. (Only those which appear brighter than

Jupiter do so.) By arranging that the same regions of the sky shall be photographed simultaneously at the two stations, 25 miles apart, it is possible to get many of these trails in duplicate, and to work out the height and actual position of the meteor track. Moreover, a shutter with narrow arms something like an electric fan is placed in front of the cameras, so that the meteor trail is broken by interruptions made 20 times per second. This makes it possible in favorable cases to find the velocity accurately, and to compute the orbit in which the meteor was moving before it hit the earth. The majority of these so far studied have had orbits of pretty short period, closely resembling those of the recently discovered asteroids like "Reinmuth's object" which passed close to the earth. The main difference is that these asteroids are something like a mile in diameter, and the meteors probably an inch or so. A decade of such observations should tell us what proportion of these bright meteors move in orbits of long period, like the comets and some well-known meteor swarms, and whether any of them have entered the solar system from outside.

BURNS, of Allegheny, reported some important spectroscopic observations, clearing up several doubtful questions of identification of elements in the sun. Caesium, whose strongest lines lie in the infra-red, has been detected by the presence of these lines in sun-spots. Tantalum, whose presence was doubtful, appears to be confirmed. Tin, which presented an unusually perplexing problem, is at last definitely identified. Only one out of three or four good lines is free from interference by blends with other elements, but this line has been recorded as due to iron. It has long been suspected that it was really due to tin, and appeared in the laboratory spectrum of iron because it is very hard to separate tin completely from iron by chemical methods. Working with samples of exceptionally pure iron prepared by various processes, Burns has obtained spectra which show no trace of the debatable line—thus freeing it from suspicion.

Rudnick and Elvey, at the McDonald Observatory in Texas, reported on an excellent photo-electric light-curve of the eclipsing variable μ_1 *Scorpii.* This pair—long known to be double from spectroscopic observations—has a period of about a day and a half and consists of two stars of about equal size and somewhat unequal brightness, very close to one another. The observations with the photometer and spectroscope make it possible to determine the actual diameters of the stars: a preliminary study indicates that they are five or six times as big as the sun. This is no novelty; but the distance of this star is reliably known—since it is a member of Kapteyn's great moving cluster—and hence its actual brightness can be found. Knowing its size, the amount of light emitted per



Courtesy Extension Division, Indiana University

The unique 24-inch Schwarzschild reflector with its builder, Prof. W. A. Cogshall of Indiana University, who has been quietly working on it for several years

square mile can be calculated and compared with the sun, and from this the surface temperature can be found. These results have not yet been worked out, but they soon will be, and when they are we shall have a much more trustworthy determination of the temperature of a star of Class B than any which is at present available.

From the Yerkes Observatory, Struve and van Biesbroeck described a remarkably ingenious spectrograph for studying the spectra of faint nebulae. Greenstein and Henyey, with this instrument, have found that the nebulae near Gamma Cygni show the bright forbidden line λ3727 of oxygen. The star, whose light undoubtedly stimulates the nebula to shine, is a relatively cool one (Class F8) and a typical super-giant. To stir up oxygen atoms in the nebula to shine as they do requires ultra-violet light of much shorter wavelength than it had previously been supposed such a star could emit, but there seems to be no escape from the conclusion that it does. There is a good deal of other evidence that the cooler stars, and notably the sun, send out more short-wave radiation than had been supposed, and it is now up to theoretical investigators to find out why and how they do.

On the instrumental side a report was presented by our host, Professor Cogshall, of the first observation with a reflecting telescope of unique type. Long ago, before the Great War, Schwarzschild had shown by difficult mathematical analysis that it was possible to make a reflecting telescope which would have a wide field of good definition, instead of the very limited one provided by the ordinary paraboloidal mirror. But the difficulties of construction of the mirrors were so great as to deter the most courageous. The curves defining these forms were of the fourth degree, and it was a hard job to figure the glass to the proper shape, and test it to be sure that this had been attained. Cogshall, working alone, and with limited financial resources behind him, computed the curves for a 24-inch reflector, and ground and polished the mirrors himself. The mounting shown in our illustration was constructed, and a modest new observatory erected to house it. Last week, its designer had the pleasure of showing to the Society some of the first photographs taken with this instrument—which, to this day, is the only example of this theoretically very important and promising type. The adjustments of such an instrument are unusually intricate and delicate, and the finishing touches have not yet been made; but, even so, the plates show that a wide field of good definition has been attained, far surpassing that of any reflector of the ordinary type. This form of reflecting telescope, with a concave secondary mirror half the diameter of the primary, gives good star images over a field four degrees in diameter. The plate holder may be seen, about half way between the mirrors.

LAST, but not least, must be recorded the award of the Annie J. Cannon Prize to Mrs. Sitterly—formerly Miss Charlotte Moore. This prize—established by Miss Cannon from a considerable prize which she had herself been awarded—is given every three years by the Council of the American Astronomical Society to some woman, without regard to nationality, who has done distinguished work in astronomy. Mrs. Sitterly's work in spectroscopy, especially on the sun-spot spectrum and the identification of solar lines, has placed her in the front rank of workers of this field; and the award has met with unanimous approval—as did that to Mrs. Gaposchkin three years ago.—*Bloomington, Indiana, January 3, 1938.*

China and Modern Science

Though the Times Were Ripe in Ancient China's Civilization, Pure (Hence Practical) Science did Not Develop There Because China was too Practical!

By RUFUS SUTER
Library of Congress

CHINA invented printing from type; China invented gun powder; China probably invented the mariner's compass.

For centuries the culture of this so-called "backward" nation was the equal of, and in some respects superior to, that of western nations. In number of first-class intellects, wealth of dominions, political organization, literature, art, flood control, and soil conservation, her record was enviable. As late as the end of the 18th Century even the state of public sanitation was probably not much different from that of Great Britain. Why, then, did not China instead of Europe give birth to modern science? If we knew the reason we should know why the Celestial Empire today is relatively helpless, whereas countries which were still semi-barbarous while she was enjoying the fruits of a refined civilization have become world powers.

One reason why China did not give birth to modern science was her civil service examination system. Suppose that in the first century of the Christian era the papacy in Rome had started a 2000-year career not only as religious head of Europe but also as temporal master with a strong army to back up her will. Imagine then that she had established the history of Herodotus, the "Odyssey" of Homer, the moral and political writings of Aristotle, and some work on sooth-saying, as an authoritative canon to furnish the sole subject-matter for education and for the examinations which were to be the "open sesame" to public office. This metaphor is not too accurate but it gives an idea of what was the actual situation in China for approximately 2000 years before the decline of the last imperial dynasty. The emperors, who were the vice-gerents of heaven as well as the rulers of men, inculcated through the centuries in the minds of their subjects the notion that the Classics were ultimately authoritative. The civil service examinations became almost exclusively the road to officialdom in the imperial capital and in the provinces, and indeed were the road to any form of social prestige. Dynasties changed but this basic policy remained. Thus one may readily have a suspicion of why capable and ambitious men in the Middle Kingdom were content to confine themselves to the study of "The Book of History," "The Book of Odes," "The Book of Changes," and the other Confucian Classics. There was no economic occasion, nor any other sort of practical occasion, for investigating natural phenomena for their own sake.

Wider and deeper consideration suggests another reason why modern science did not emerge natively in China. The peculiar set of circumstances which occurred in the west before the advent of science in the 16th Century did not have any counterpart in the Celestial Empire. We may assume, in other words, that when science sprang forth fully developed in the west, with the new attitude towards nature of Vesalius, Kepler, Galileo, Harvey, and the others of that unrivalled galaxy of geniuses, this growth required just the background which historically it had.

The scientific awakening in Europe began as one aspect of a general reaction against the unempirical cast of thinking of the Middle Ages. Its claims were less ambitious than those of the schoolmen. It did not seek to fathom the attributes of God and the human soul, or the divine purpose in creating. It only sought to ferret out by careful watching, as the skilful mechanic does, how things work: the rate of acceleration, for example, of a ball rolling down an inclined plane.

THIS increased stress on the importance for knowledge of observed fact, however, was not the whole of the secret of the scientific awakening. If science was a reaction against the omniscient deductive structure of the Middle Ages it was also the heir of the Middle Ages. They bequeathed to it the idea that nature is orderly, a conviction without which science is impossible because in its absence observation and experiment yield only a miscellany of disjointed bits of curious information about things, which is what native Chinese natural knowledge was. We should not underestimate the number of such items of information acquired by the ancient Chinese. They developed methods of extending the life period of the soil, knew the medicinal value of herbs, foretold eclipses, measured the length of the year with extraordinary accuracy, devised a primitive seismoscope. Indeed, their discoveries and inventions were well nigh numberless. But Chinese natural knowledge always remained piecemeal. It never had the capacity to develop into an organized whole where one discovery would point to others beyond itself and so would eventually permit a really farsighted, effective control of nature on a vast scale.

That we inherited the conviction of the orderliness of nature from our mediæval ancestors is seldom realized. We think of our forebears as living in an orgy of supernaturalism, seeing miraculous, arbitrary interventions of the hand of a divine Despot everywhere. But, while this may have been true of the masses, it certainly does not reflect the thought of the learned. That the schoolmen reasoned syllogistically alone disproves it, for people who reasoned syllogistically must have believed that the world was arranged according to a pattern to which the syllogism would apply. The world for our ancestors was a network of premises and conclusions. Or, to describe the picture in another way, the universe was a lawyer's brief. Whatever may have been the defects of this conception it did not err in the direction of disregarding the orderliness of nature, for orderliness belongs as essentially to a lawyer's brief as to a machine (the pattern after which the fathers of modern science conceived of the universe), or as to a set of mathematical equations (the picture some of our 20th Century scholars entertain of their environment).

The schoolmen did not originate this rigorous legalistic conception of the world. They inherited it. For centuries, however, they mulled over it, devised precise ways of expressing its details in technical language, analyzed and synthesized it, wrangled about it, and split hairs to a degree of nicety which to us of today seems ridiculous. The result was, nevertheless, that the conviction of the orderliness of nature was indelibly imprinted on the cultivated western mind. It became instinctive. When the 16th Century arrived the stage was set.

The fathers of modern science had merely to appreciate that the powerful and efficient, indeed the sole effective, way of finding the lines of orderliness was to observe and experiment. They took for granted that the laws were *there*. Every event happened according to *some* law. The puzzle was to discover *which* laws, and this could be done by watching. Then, when the laws were unravelled, there was no end to the previously unknown facts and additional laws which would be suggested, to the predictions which could be made, to the information about the past, the invisible, the unobservably small, and the unobservable large, which could be gleaned, to the practical applications which could be maneuvered, and to the development of means of harnessing the forces of nature for human use.

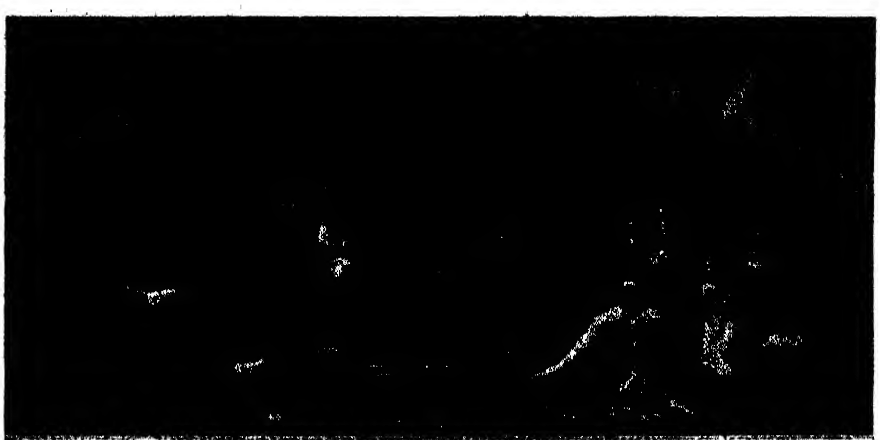


Photo Alinari, Florence

Galileo Galilei was not "ashamed" to perform experiments with little balls and inclined planes, and then to fight for his findings until they took root and modern science grew from them and from him. Giuseppe Bezzuoli's painting in the Museum of Physics and Natural History, Florence, Italy, depicts him at the age of about 26 (1590) making his famous experiment at Pisa before the illuminati. Two men at the left are "settling" the question by looking it up in Aristotle, whose authority was universally regarded as final, whether his *a priori* reasoning agreed with actual experiment or not. Like the Chinese, the Greeks would not experiment; only slaves used their hands. This delayed science over 2000 years

One has no grounds for supposing that the Chinese, if they had enjoyed the long western training in seeing the world as orderly, would not likewise have given birth to science. As it was, unfortunately, they were not aware that beneath the helter-skelter of natural phenomena are fixed grooves in which all happenings fall if the puzzle is pondered sufficiently. Hence their observations and experiments led nowhere.

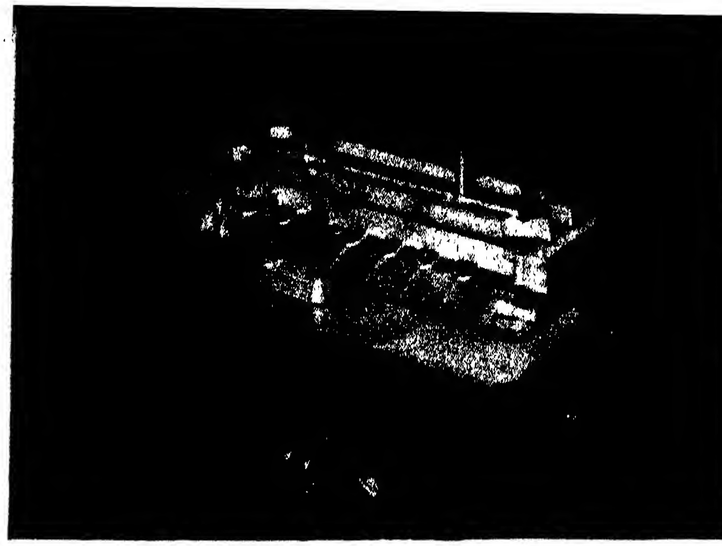
WE now come to a possible third reason why science did not develop indigenously in the Middle Kingdom. One hesitates to mention it because it belongs in the realm of the speculative more obviously than did the other two reasons, and it may have no basis in fact. If we consider it we should do so with reservation. It is associated with a cast of mind which in the past was widespread among the Chinese intelligentsia. This cast of mind may have been a result of the civil service examination system, or it may have been a natural character of the Chinese mentality (if such an expression means anything, which is doubtful since the best psychological opinion of today is that no innate distinguishing national or racial mental traits exist). At any rate, the scholarly class among the Chinese in the past, and to a remarkable extent in the present, was and is marked by a practicalness of interest which has not characterized the corresponding class in western lands since the days of classical Greece and Rome. The Chinese scholar was a practical, common sense, dignified man. He would have been ashamed to roll balls down inclined planes merely to measure their acceleration accurately, as did Galileo. Such an occupation would have been childish and not worthy of a fully matured human being who had better be concerned with the serious problems of statecraft, economic organization, moral training, and history; or, if he had an impractical moment, he might study an ode.

One would imagine that this practical bent would have been good soil for the development of science in China. Here, however, we come face to face with one of the paradoxes in the story of man's struggle to master his environment. While modern science in the west has effected an intensely practical revolution in every aspect of life it was not at its inception a consciously practical venture, nor has it been since in the hands of the men who have done most to push its frontiers into new territory. When Galileo performed his experiments with the balls and the inclined planes he was not consciously and deliberately creating the science of dynamics which was destined to play a rôle in the transformation of an agricultural society into our modern industrial civilization with its amazing feats of engineering. The same may be said of Faraday and Maxwell. The innumerable practical applications of our knowledge of electricity and magnetism were made possible partly by their investigations, but they were pure scientists interested in electrical and magnetic phenomena for their own sake. As striking an example of this paradox was Roentgen's discovery of the X ray. He was a typical German professor isolated from the world and as concentrated on exclusively theoretical questions as is Einstein. His discovery, nevertheless, has been of as great humanitarian value as that of anesthetics.

There is nothing mysterious in this circumstance that theoretical inquiries have commonly preceded practical applications. It is simply that first principles are more readily accessible to minds not distracted by concern with the question of use. It is, curiously, a *practical* disadvantage to the development of a science, particularly at the initial stage, for the explorers to remain at the utilitarian level. Once the theoretical principles are laid bare practical applications will naturally follow without any pressure in that direction by the pioneers. To cite an illustration which at first glance will seem farfetched: the obvious utilitarian value of observing the stars must have been in the beginning to predict future happenings in the body-politic. It was a bold man, absurdly impractical and oblivious to public opinion, who at some date in our western history made the leap from astrology to astronomy, first plotted the movements of the heavenly bodies just to learn how they move and not to discover whether some monarch's reign was to be successful.

THIS degree of impracticalness never occurred among the Chinese intelligentsia, or if it did it was swiftly suppressed by the authorities. There was a long line of eminent men in the Middle Kingdom who were official court astrologers and who made accurate observations with excellent instruments of precision. They all, however, labored under the delusion that the affairs of this world are determined by, and to be read in, the heavenly bodies. They were too practical (or perhaps it was their superiors who were too practical) to free themselves of the ideal of political or social utility and to assume a point of view which could have permitted the evolution of a pure science of astronomy capable of begetting practically utilisable information.

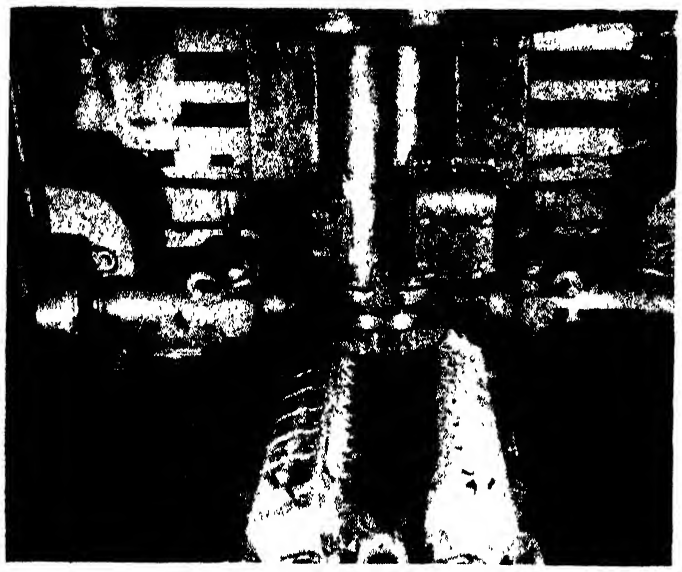
An analogous situation frustrated the growth of native Chinese mathematics, geology, zoology, anatomy, and medicine, all of which by the richness of their beginnings gave promise of marvelous development, but in the end did not liberate themselves from the pseudoscience—practical, often beneficent in its motivation—of sooth-saying.



2 An aluminum pattern of the bottom of the engine block. A mixture of sand, clay, and graphite is packed over this, held in place by a metal box called a flask. The flask is inverted, the pattern removed, the cores are assembled in the cavity, and molten iron is poured into the spaces

1 All motor-car engines have their beginnings in sand. In one phase of the foundry procedure oil-treated sand is compressed in core boxes and the resultant mold is baked to produce the core. The core shown above will be used to shape the inner cylinder walls of one of the two eight-cylinder banks of a Cadillac Sixteen engine. The other photos on this page show the same engine taking form

A Motor-Car

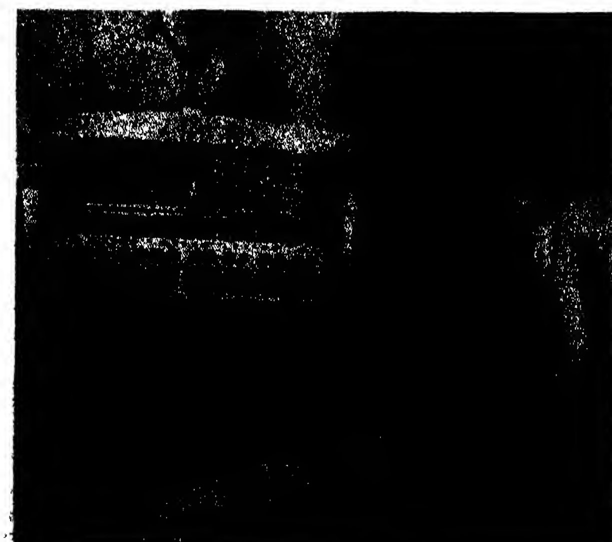


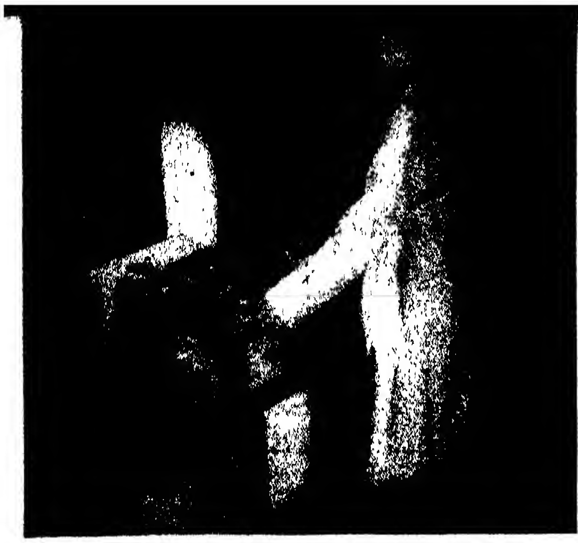
3 *Left:* The block, scoured free of sand, receives the first touch of the milling machine. One cutter smooths the oil-pan face while two side cutters take care of the engine support brackets. Here, and in subsequent operations to final assembly, the block is placed upside down

4 While the block is in process of manufacture, other motor parts are being made and machined. A delicate scale (*right*) weighs sets of pistons, rings, pins, and the small end only of connecting rods, to produce matched sets for smooth operation

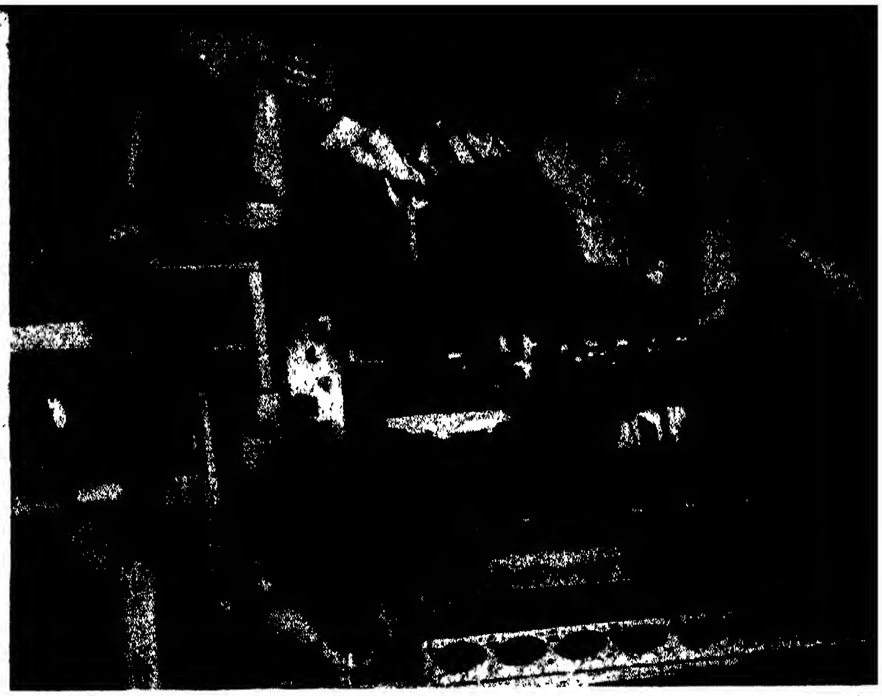
5 Ten multiple-drill machines, marking ten steps in manufacture, drill 301 holes in the block for accessories, oil passages, and assembly. Blocks are drilled for one function on one side, reversed, and the process repeated. In the machine below, holes for valve-lifter and valve-guide bearings are being drilled simultaneously

6 Fragments of metal or grime, once enclosed in the engine, would ruin the fine piece of machinery. In one of the final series of washings, shown below, a cleaning solution of boiling kerosene and water is forced under high pressure through all of the oil lines





7 The engine crankshaft, one of the most intricate masses in the unit, must be perfectly balanced. Set up as shown above and revolved at high speed, balance within 0.5 inch-ounce is indicated on the oscillograph



8 With the block still upside down, the crankshaft is lowered into position. At the left end of the shaft is the clutch and flywheel assembly. After the crankshaft is placed, the pistons and rods are inserted from below and the motor pan is attached. Compactness of the new Sixteen is evident here. The crankshaft is much shorter than those designed for use in previous models of the same general engine type

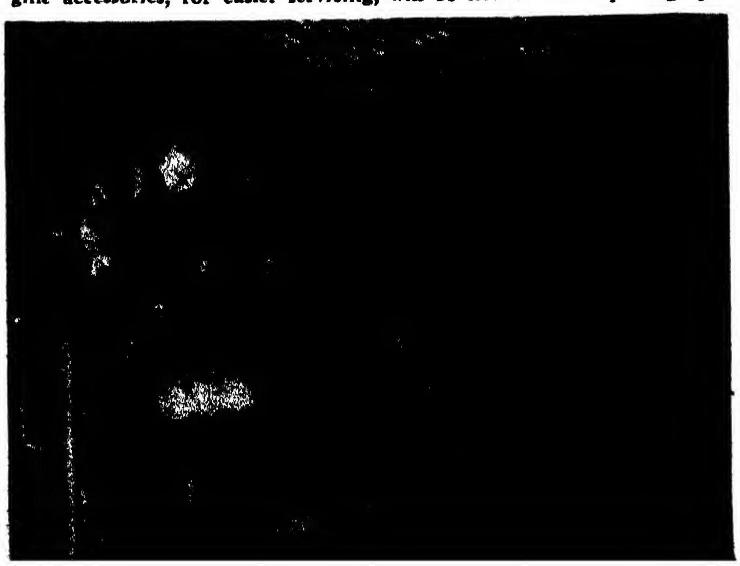
ENGINE TAKES FORM

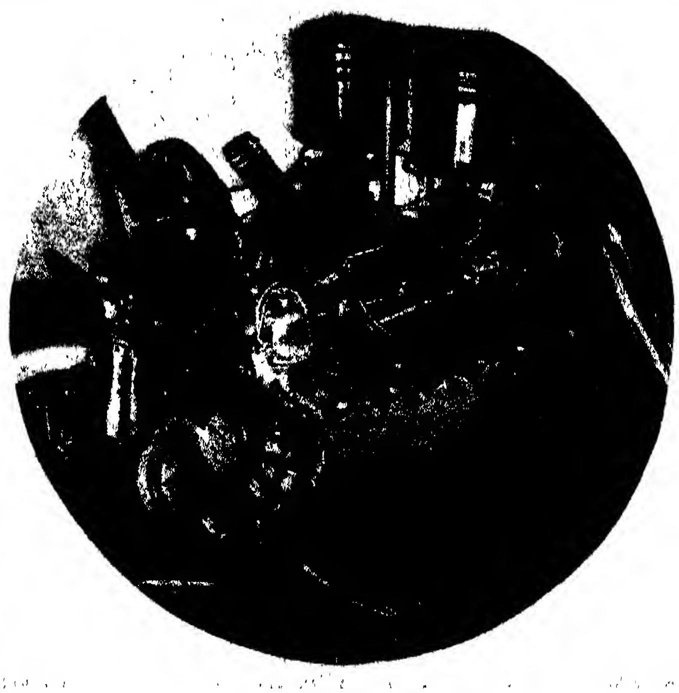
By A. P. PECK

9 *Right:* The transmission has been fitted and the engine has been placed right-side up. The workman is fitting into place the various accessories. Counting generators, carbureters, and so on, as one part each, the new Sixteen has 1627 parts; last year's Sixteen model had 3273 parts

10 *Below:* The completed motor is tested on the dynamometer. At full throttle, the dials will register 185 horsepower. Essentially, the dynamometer consists of a specially designed electric generator coupled to the shaft of the engine and acting as a load or brake to absorb the power developed. Power output of the motor-car engine is then indicated on electric meters

11 *Lower right:* Ready for the radiator, the completely assembled engine rests low in the chassis, the 135-degree design of the two cylinder banks making for a low center of gravity. Duplicate sets of engine accessories, for easier servicing, will be noted in this photograph





CAMERA ENGRAVING

Photo-Engraving Conquering a New, Difficult Field . . . Makes Printing Rolls for Textiles, Wall Paper . . . Certain Advantages over Older Methods

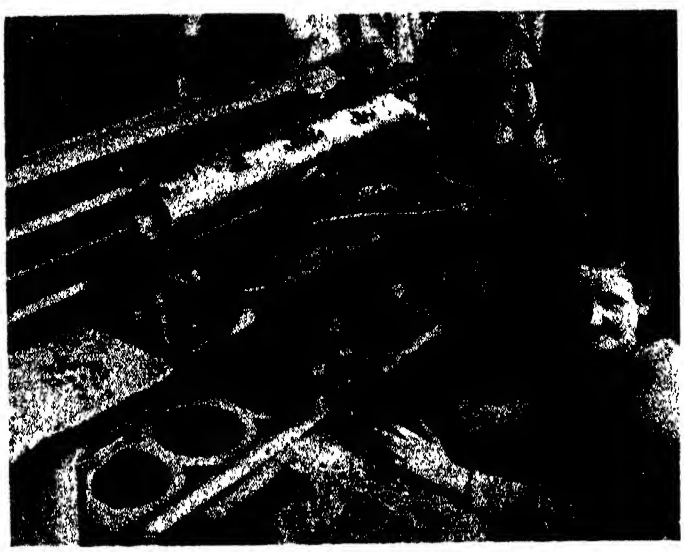
By PHILIP H. SMITH

UNREMITTING research is responsible for putting within the reach of the average person's pocketbook oil-cloth, textile and wall paper products which were non-existent a few years ago.

You can now purchase oil-cloth sporting highly complex, multi-color designs which reproduce the artists' conceptions with absolute fidelity; you can get textiles printed to give the appearance of furs, and wall papers which have the surface look of grained woods or coarse weave textiles, all perfect as to detail.

The means for obtaining this hitherto impossible in designs has been photo-engraving. All of these products are printed from engraved copper rolls and it is the substitution of the camera for the hand in the application of the pattern to the roll that has permitted the reproduction of intricate detail to achieve many phenomenal effects.

The triumph of photo-engraving in these three fields is more than an extension of the long successful color-process printing of paper. Each field has presented a different combination of problems requiring specific solutions. Much has had to be forgotten as well as learned to make the process work successfully, and even now its rôle is limited and supplementary to existing processes. Broadly speaking, photo-engraving is being used in these new fields chiefly where the older processes cannot be used because the length of time required to reproduce intricate detail on the roll by older methods would make costs prohibitive, or because the human hand is unable to execute detail faithfully.



In the pantograph method of engraving rolls, the operator traces the design, diamond points scratch the varnished roll

WHEN mechanization comes to an industry, it is expected to replace hand work. It usually does. But photo-engraving applied to the production processes of these three products has been unable to abolish all hand skill. We have, therefore, a situation that is unique. We start with the camera which is known to register detail with extreme accuracy. We apply it in competition with the human hand and eye, known for their fallibility as well as great skill, and expect to see it triumph quickly. After many years of trial and error, it fails to conquer completely. This must be explained.

So we have here a progress report—the story of beginnings and accomplishments; when we have surveyed the record we may be able to determine how much farther photo-engraving is likely to go. Will it ultimately sweep the field? What will it mean to the reduction of production costs? Those who are devoting all their energies to perfecting the process declare that wider application is only a matter of time and closer co-operation between the parties who might benefit. But we cannot agree or disagree until we examine the various processes and the problems to be faced.

There are four methods of engraving printing rolls—hand, mill and die, pantograph, and photographic. In the first method, an outline of the pattern to be reproduced is cut on the copper roll. The hand engraver then punches or cuts very small points, or pins, on the ground surface of the roll, which, in turn, carry the color. Heavy tones are obtained by cutting large pins and vice versa. Multi-color work calls for a separate roll for each color. However, by allowing the pins carrying one color to fall over the pins carrying another color, a mixture of the two colors can be obtained to create new shades. This is the most laborious process and usually the most expensive.

Mill and die engraving is much faster. The first step is to turn a piece of steel, especially prepared, into the required diameter, and to cut into it a single repeat of the pattern to be engraved. After cutting the design, the steel is hardened by heat. It is then placed in a machine and the design transferred to a steel roll of the proper diameter by applying extreme pressure, thereby raising what is called a mill. The mill presents just the reverse of the die. Then the roll is placed in an engraving machine and the design is transferred, once more under pressure, this time to a copper roll.

In photo-engraving, sensitized carbon tissue transfers design to roller ready for etching

Pantograph engraving is the fastest and least expensive process, but its application is limited to a particular type of design. Here the design is etched or hand cut on a zinc plate on a scale several times larger than the original. This plate is put into a pantograph together with a copper roll which has been treated with an acid-resisting varnish. The operator then traces the design as it appears on the zinc plate and the diamond points of the machine cut through the varnish simultaneously in the desired number of places, thus exposing the copper for later etching.

The photographic process is the newest. It comprises two methods—the gravure and the intaglio reverse half-tone. The former follows the rotogravure process used to print Sunday paper supplements. The design is photographed, then the negative is used to print onto a sensitized carbon tissue which is later transferred to the copper roll. The tissue must be thoroughly developed and then painted to block out any spots not to be etched. Finally the roll is placed in a bath of acid and the design is etched in the various tones appearing in the pattern.

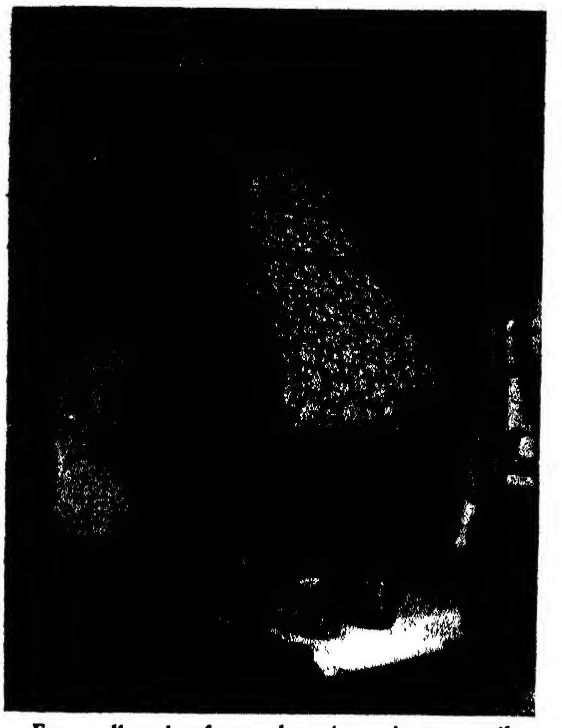
THE intaglio process is similar to rotogravure as far as the photography is involved, but instead of the amount of color being controlled by the depth of the etch, it is governed by the size of color-carrying points. These points, or pins as they are technically termed, are obtained by photographing the design through a screen (as are the half-tone cuts used in this magazine), so that the screen effect is etched into the surface of the roll to achieve, in effect, countless raised points. Pin size is controlled by screen size.

Both processes feature photographic separation of color. Thus a separate roll is produced for each of the primary colors. Then, in the printing process, when the colors are applied in their correct order, intricate patterns in soft shades can be produced on the material.

The photographic processes in the textile industry involve much secrecy. Each engraver has developed particular skills through long experience. Most of these jealously guarded secrets have to do with transfer of the design to the roll and cannot be revealed here.

Oil-cloth has been mentioned first among the industries using the photographically produced roll because adoption is most widespread and perhaps most successful. Commercial, economic, and technical conditions combine to make it most practical and it is here that the intaglio half-tone process is being used. The surface of the material and the cellulose acetate lacquers with which it is printed can be handled excellently. Hitherto, large designs with intricate detail and shading were too costly to produce, and the manufacturer had to be content with simple geometric patterns. Even now, the latter type of design can be produced more cheaply with the pantograph method if there is no color gradation.

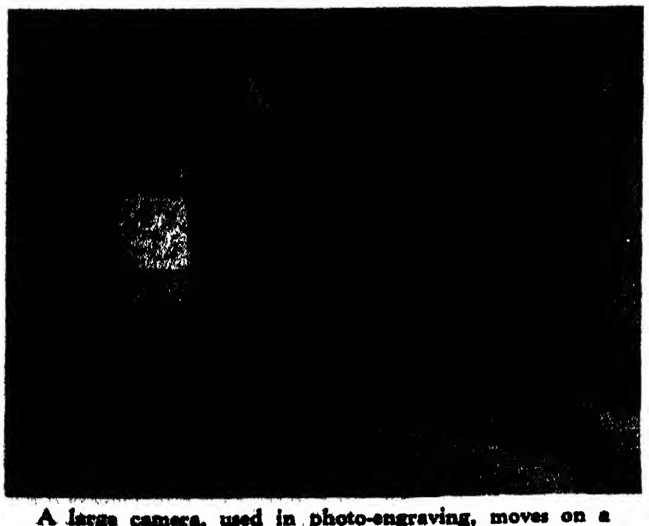
The photo-engraver who works in the textile field has a wholly different set of conditions to meet. The material upon which the printing is done, the colors, the machinery, and the designs, are quite unlike those found in oil-cloth manufacture. Here, application of photo-engraving began with silks which had a smooth surface and a selling price high enough to justify the cost of experimentation. From silks, the next step was to cotton and today more and more cotton-printing rolls are being produced by the photographic method.



Four rolls print four colors, in register, on oil cloth as it turns around this revolving drum

The camera is used only when designs are complex and involve a great deal of shading. If the pantograph can be used for simpler work, it wins on a price basis. But there are instances where only the photographic process produces the desired results. If you have seen fabrics which give the effect of furs, you have seen the best possible example. No human hand could ever engrave the intricate detail of fur texture.

Multi-color work is done with the new process quite successfully, but the best results are obtained when the design bases on the three primary colors. When rolls are made with definite color use in mind, the colors cannot be switched satisfactorily and for that reason hand-engraved rolls are often preferred, simply because more rolls are



A large camera, used in photo-engraving, moves on a heavy frame during focusing: A design being photographed

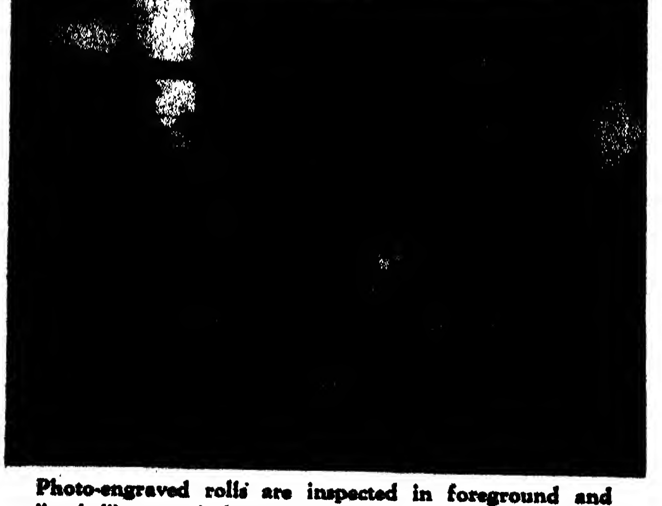
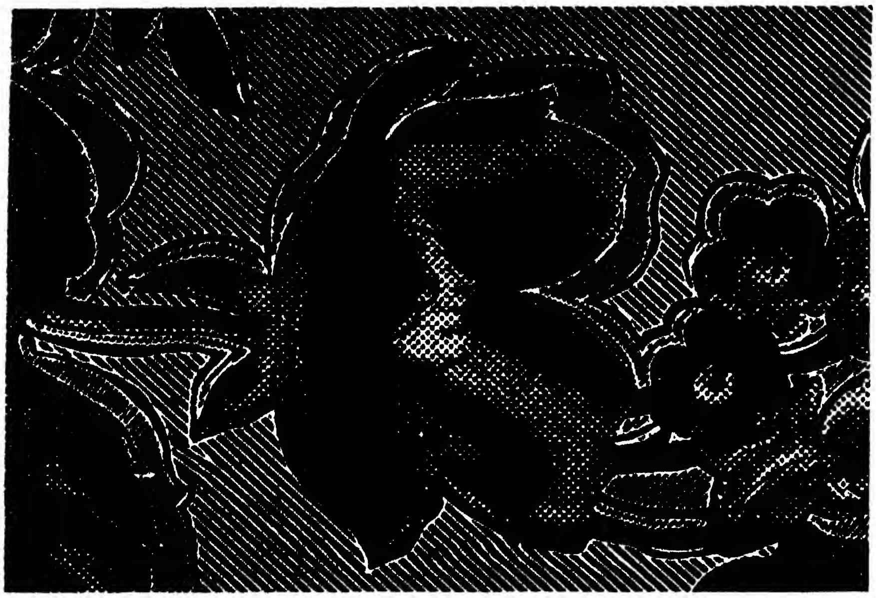


Photo-engraved rolls are inspected in foreground and "tooled" near windows to clean up and to correct errors



Part of design for a roll, reproduced at twice the original size to show versatility of photo-engraving. Gradations of tone are obtained by dots and a variety of lines

used. In other words, the photo-engraver tries to achieve, with few rolls, the same effects that heretofore have been created with many hand-made rolls.

The engraver who works in the textile field, unlike the man who produces for oil cloth, has a material into which the colors must strike fairly deeply. The colors, too, vary in that chemicals are used which, in the printing, develop into color only after passage through chemical solutions.

IN the third field, that of wall paper, photo-engraving has made least progress and for several good reasons which do not necessarily cast any reflections on the process. Only about 10 percent of wall papers are engraved. This means that the volume of business is not sufficient to warrant the cost of extensive experimental work. Nor is the demand for wall papers such that designs of the character best produced by photography have any great field. Wall paper has one very fundamental difference from either oil-cloth or textiles in that it appears before the eye always in measured strips which must be identical. The camera, which reproduces with fidelity, catches all defects as well as effects. The slightest discrepancy in the process of transferring the design to the roll will stand revealed when strips are laid side by side to match the design. Likewise, if the etching process is not uniform over the entire surface, the paper will be streaked.

Intricacy of design and the extent of shading is again the deciding point in the type of process to be used, with the exception that there are certain designs which can be reproduced only by photography. We find these to be wood grains and textiles where the amount of detail would swamp the hand engraver.

At this point we can begin to draw some conclusions regarding the photographic process in general and as it applies in the different fields.

The first and perhaps most obvious conclusion is that photo-engraving is by no means a completely mechanized process. Individual skill and artistry has not been abolished by the camera; what has happened is that the skill of the hand engraver has been simply transferred to the photo-engraver. In unskilled hands, no worthwhile results can be achieved. The photo-engraver must have the skill of the artist at his finger tips and have intimate knowledge of design and process.

Since the engraver is not the designer nor the printer, a high degree of co-operation must exist between these three principal factors; where that has been brought about the greatest progress has been achieved. Designing for the photographic process is now a definite art with very few skilled practitioners; the handling of color and the actual printing process have been altered to meet the exigencies.

Probably the greatest conquest by the photographic process will be made in the oil-cloth field where results already point the way. Yet 100 percent use is not anticipated. Even photo-engravers admit that very often costs can be held down by limiting the use to backgrounds and combining with hand-engraving for full design effect. On the other hand, they are quick to point to great savings when applied to certain designs. If, as it happens, hand operations will take three months to achieve the same result that can be had in three weeks with photography, the latter will win even though the roll cost might be higher.

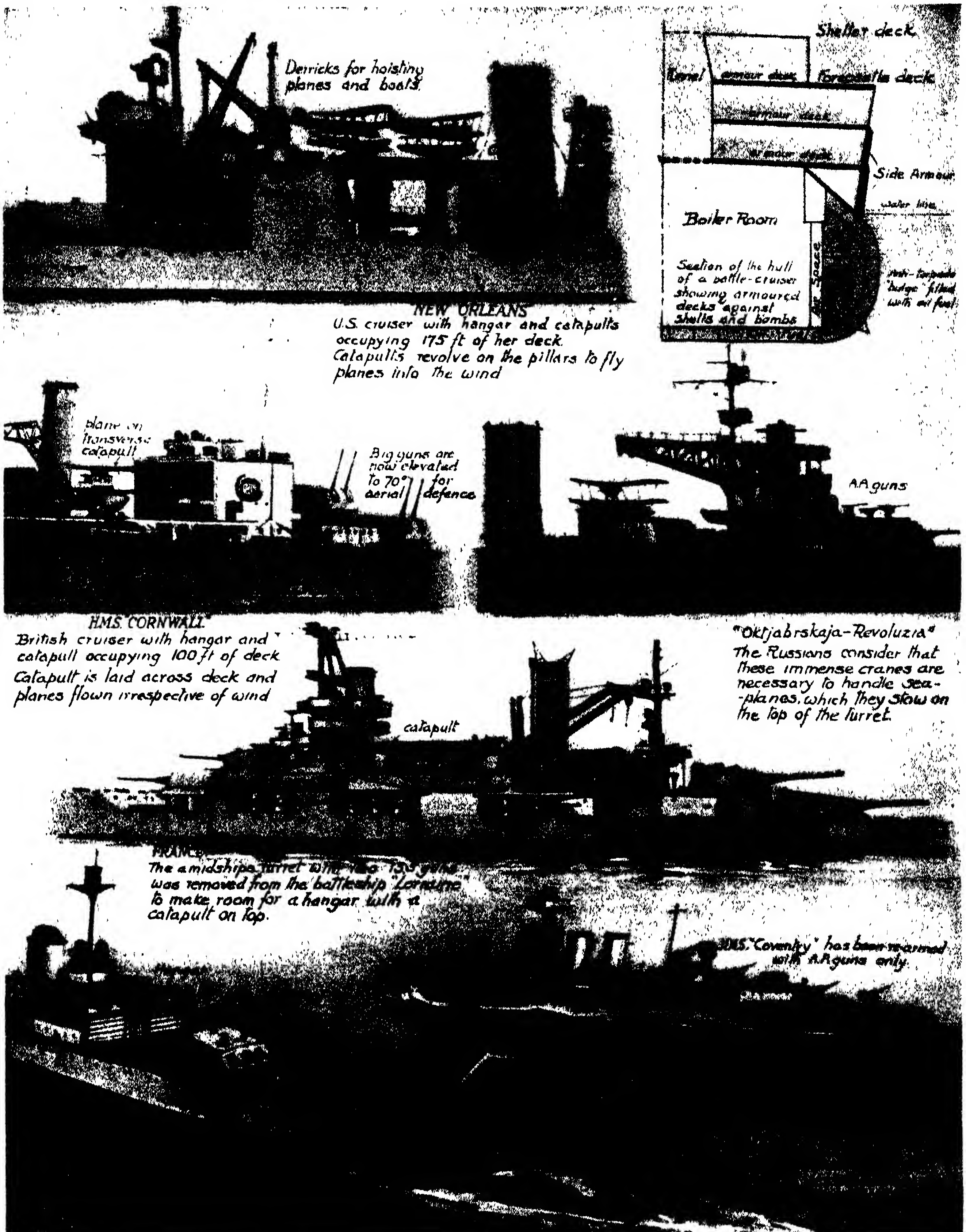
In the textile field, we find style operating as a major factor. If fashion decrees the use of solid color fabrics, development of photo-engraving slows; but in the main it keeps moving steadily ahead. Early attempts at introduction were costly and unsatisfactory and gave the process a black-eye from which it has not yet fully recovered. Many photo-engravers sprang up who could not deliver the goods, but did last long enough to create a host of skeptics. Now the ill effects are wearing off and more developmental work is in progress, looking to more accurate and inexpensive multi-color work.

Still another set of conditions govern the wall-paper field. Here it is a decorative effect that is sought rather than detail and it is detail that the camera offers. Manufacturers see no over-all advantage to be gained from pushing the photographic process as long as costs exceed that of hand work. They admit, however, that much might be achieved if designer, engraver, and printer worked together, but they must first see possibilities of increased commercial demand.

CRITICISM is rampant in every branch of photo-engraving activity. Each party looks to the other to make the successful contribution when joint enterprise is perhaps the only way to reach the goal. But it all sums up to this: mistakes and failures are always obvious and invariably aired during the trying period of experimentation. It is just another way of saying that progress is being made and that the last word has yet to be uttered. Photo-engraving is being adopted just as quickly as it does a better job, or an equally good job at lower cost, and it already has made a permanent place for itself.

Large printing or embossing rolls present many operating problems

Illustrations courtesy of Chambers-Storck Co.; Fabrikoid Division, E. I. duPont de Nemours & Co. Inc.; Nu-Process Roller Corp.; U. S. Finishing Co.; Wadsworth & Woodman Co.



Courtesy *The Illustrated London News*

Aircraft Have Influenced Warship Design

INCREASING use of airplanes by navies has forced modifications of warship design for more effective use of, and protection against, them. In the drawing by the naval authority, Dr. Oscar Parkes, are shown some of the developments already made. It will be noted that deck space is conserved by British practice, shown on H. M. S. *Cornwall*, of installing a transverse catapult, whereas on the U. S. S. *New Orleans* the catapult must swing in all directions to face the wind. Other innovations are the full elevation of the main armament guns, and the addition of much armor for deck protection.

THE SCIENCE OF

By SIDNEY J. FRENCH
Assistant Professor of Chemistry, Colgate University, Hamilton, N. Y.

(In Two Parts—Part Two)

IN Part I of this series the three important factors which govern the formation of alloys were considered. They had to do with the particular pattern of crystal lattice formed by a metal, with the number of outpost electrons belonging to the atom of a given metal, and with the relative sizes of the atoms. While these are by no means the only factors that influence the formation of alloys, they are decidedly the most important.

But, before considering alloys themselves, we may well consider the factors which distinguish metals rather sharply from other substances, the factors which permit metals to be flattened into thin sheets, bent, or drawn into fine wires without crumbling. What property possessed by the atom accounts for these unusual phenomena? A simple analogy will help in answering the question. Imagine a flexible box filled with marbles all of the same size. Now put pressure on one edge of the box. The whole pattern is distorted or warped out of shape as the marbles slide and roll over one another to take up new positions. The serried lines of the original formation are skewed into a new alinement; but still, each marble maintains its contacts with its original fellows (Figure 10).

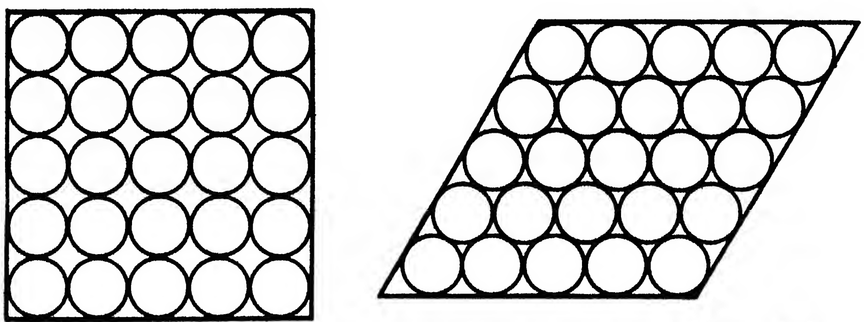


Figure 10: **Illustrating the slipping of metal atoms past one another when pressure is put on the metal: the left-hand arrangement changes to the other**

In a similar manner metal atoms slide and slip past one another when pressure is put on the metal. By further stretching, the metal can be drawn into a wire. But the marble analogy falls down in one important respect—marbles are held together only by the force of gravity while atoms have electrons to hold them together in a more powerful bond. However, if the electrons per atom are few in number, the bond, though firm, is not rigid, and atoms may slip and slide into new positions to distort the crystal structure without parting from their neighbors. And, if the atoms are relatively large, the skewing process is more easily accomplished. We find, then, that metals having large atoms and few outer electrons per atom are the most malleable and ductile, the most easily bent or worked, and the softest of the metals. And, in addition, they are the best conductors of heat and electricity. In this class come three of our most important metals—gold, silver, and copper—followed closely by the useful lead, tin, pure iron, and aluminum.

The slipping of atoms past one another will take place most readily where the distances between atoms are the greatest, for it is there that the forces holding the atoms in position are the smallest. Just as the distances between corn plants in a symmetrically planted corn field depend upon the particular angle of view—on the particular row under observation—so, too, the distances between atoms in a metal crystal lattice will vary. (See Figures 2 and 3 of Part I.) On the bias, where distances are greatest and binding forces weakest, skewing will be at a maximum. Here lie the so-called slip planes; here it is that the first "give" takes place when pressure is put on the metal.

Many of the metals have modified crystal lattices in which the atoms are closer together in one dimension than in another. Such metals have very definite slip planes or planes of weakness which confer great ductility, malleability, and softness on the metal (Figure 11).

Perhaps the best example of a substance exhibiting marked slip planes is to be found, not among the metals, but in graphite, a peculiarly crystalline type of carbon. Here the tiny unit crystal is a hexagon composed of six carbon atoms. Within the hexagon are powerful electronic forces binding the atoms together to give a hard, rigid structure. But between adjacent hexagons distances are greater and forces weaker. Hence, these tiny hexagons slip past one another with ease to give the smooth greasy touch and apparent softness so familiar in graphite (Figure 12). So smoothly do these tiny crystals slip past one another that graphite finds important uses as a lubricant. But graphite is unlike the metals in that it lacks the clinging power of the metal atoms, the force which still ties atoms together even though they be warped far out of position.

TO return again to our marble analogy, let us imagine that the marbles are now set in glue, so that each marble is rigidly attached to its neighbors. Pressure on one edge of the box results not in the even slipping and sliding of marbles but in irregular breaks between various clumps of marbles. Gone now is the former flexibility; in its place we have rigidity and brittleness. We have a good representation of the brittle metals such as chromium, bismuth, or antimony which shatter into fragments at the blow of a hammer, which break instead of bend, which are poor conductors of heat and electricity and which cannot be machined. These are the metals in which the atoms are tied rigidly together by

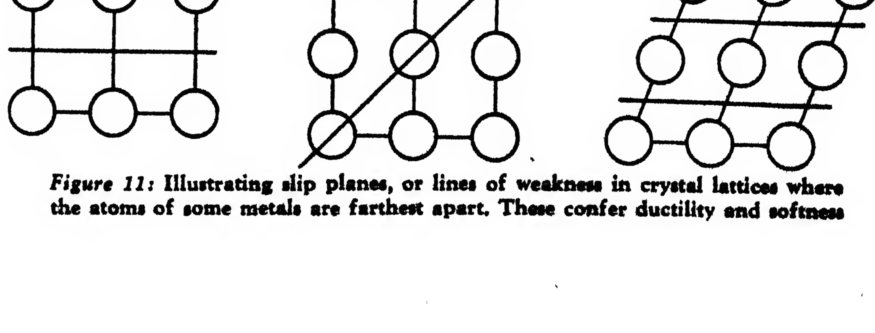


Figure 11: **Illustrating slip planes, or lines of weakness in crystal lattices where the atoms of some metals are farthest apart. These confer ductility and softness**

Alloy Building

Why Metals Can be Worked . . . Why Graphite is a Lubricant . . . Why Some Metals are Brittle and Why Diamonds are Hard . . . Why Carbon Hardens Steel

the large number of electrons present per atom. There is little chance for distortion of the crystal lattice; there are few slip planes and little "give." If there are pronounced lines of weakness in the crystal structure, the metal, like bismuth, will fracture into shiny smooth-surfaced angular bits.

As graphite represents the extreme of softness, so the diamond, another form of crystalline carbon, represents the extreme of hardness. The carbon atoms, small in size and each with four outpost electrons, are held close together with powerful and rigid electronic forces to produce the hardest crystal known to man.

As the superstructure of a ship may be thrown into place quickly, once the keel has been laid and the ribs put in place, so we can finally fit the discussion of alloys over the somewhat extensive groundwork of fundamental principles.

We may well consider the simplest example, to start with—the case of two ideal metals whose atoms are as nearly alike as possible, having similar sizes, possessing the same number of outpost electrons and crystallizing on the same pattern. Of course, there is no such ideal case in existence but, like Plato, we can visualize Utopia. In essence, we have merely painted some white marbles red and the change in color does not prevent the marbles from fitting in their former holes. We may mix the red and white marbles in any proportions at will and they slip into their proper places without fuss or delay. So with our two ideal metals; the atoms of one may be substituted for those of the other in the crystal lattice without upsetting the pattern and without materially altering the mean properties of the alloy (Figure 13). As the average color of the box of marbles will depend on the proportion of reds and whites, so the average properties of the ideal alloy will depend alone on the proportion of each metal present and it approaches those of the metal whose atoms are present in largest number. We have, so to speak, a sliding scale the limits of which on either end are the two metals making up the alloy. Such alloys are often termed solid solutions. Alloys of gold with silver approach this ideal state, as do those of gold with copper and silver with copper.

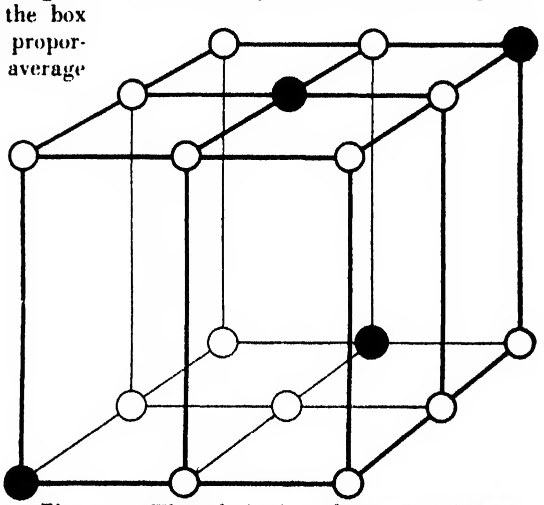


Figure 13: **The substitution of an atom of one metal for that of another in a crystal lattice causes little distortion, provided the atoms are similar (substituted atoms are shown in black)**

Having considered cases where there is a maximum of similarity between atoms, we can turn to cases where there is a maximum dissimilarity. Consider two metals in which the atoms are far apart in size and crystallize in totally different patterns. We no longer have the analogy of red and white marbles; we are dealing with footballs and golf balls.

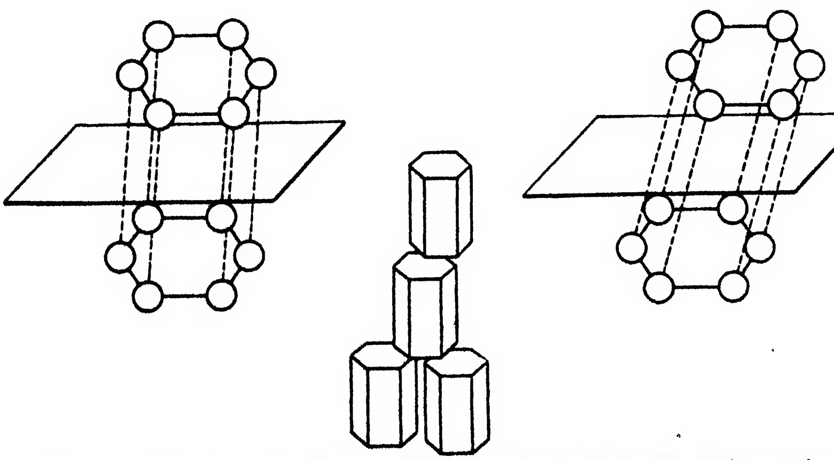


Figure 12: **Showing why a "lead" (graphite) pencil writes so smoothly: As the end crystals are caught by the paper, crystals higher up slide quite easily apart**

Shake these together in a barrel and the golf balls soon find their way to the bottom, leaving the footballs above. So it is with such unlike metals; they may not mix even when both are melted, the lighter one forming a layer over the heavier. But, even if they do mix in the liquid state, there can be no mixing when the alloy solidifies, for a football cannot take its place in the golf-ball lattice nor can a golf ball match up with a football. Each metal crystallizes separately on its own lattice pattern with its own atoms making up the lattice (Figure 14). But if the atoms are thoroughly mixed in the liquid state, only a few of one variety will be close enough together to form a crystal. Hence, the crystals of one metal will not be continuous but tiny and intermingled with tiny crystals of the other metal.

These crystals are so tiny and so interwoven that to the eye the alloy appears to be the same throughout. But polishing and etching with acid to dissolve out the boundaries between crystals throws the tiny units into a relief which becomes clearly evident under the microscope (Figure 15).

Such alloys, composed of mixed crystals of the two metals, are known as eutectic alloys when the mixture has the right proportions. In general, they are quite brittle, breaking easily at the crystal boundaries. They cannot be worked into sheets or wires because the separate crystals do not cling together but the interweaving of crystal units gives hardness and rigidity. There can be no continuous slip planes, for these are broken at the crystal boundary.

If an excess proportion of one metal is used in the preparation of such alloys,

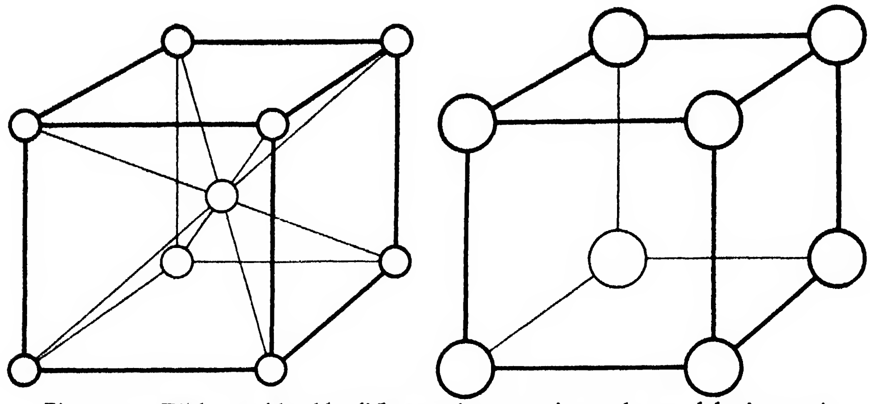


Figure 14: **With considerable difference in atom size and crystal lattice, each metal snobbily crystallizes separately and a eutectic type of alloy is thereby formed**

the eutectic alloy will be imbedded in and surrounded by the excess metal, thus providing a soft matrix for tiny crystals of harder alloy. As hard stones may be imbedded in asphalt to give a yielding yet durable surface to wear, so such alloys find valuable uses as bearing metals, the soft matrix metal supplying the necessary elasticity and the embedded alloy the durable contact points.

EUTECTIC alloys have another interesting property, that of melting or freezing at low temperature. Tin has the lowest freezing point of all the common metals, yet the eutectic alloy of tin with lead freezes considerably below the freezing point of tin itself. To explain this peculiarity, in part at least, we may use one more analogy. A football team in practise and without opponents can line up in formation quickly, but place an opposing team on the field and tangled masses of opposing players greatly retard the lining-up process. Some bewildered player may even find himself temporarily in the wrong line-up, but he is soon ejected. So, in a mixture of molten lead and tin, with each atom trying to find a place in its own line-up as the temperature falls toward the freezing point, there is great confusion and retardation of crystal formation. The temperature falls considerably below the normal freezing point before the atoms can untangle themselves and line up in crystal formation. Then, too, lead atoms have some attraction for tin atoms, even though the two cannot occupy the same crystal, and this attraction must be broken before either metal can crystallize. At lower temperatures, the tendency to fall into crystal formation overcomes the attraction between lead and tin atoms.

Eutectic alloys, and in fact, all alloys, are not necessarily limited to two metals; there may be three, four, or even a half dozen metals in the alloy. This, of course, leads to very complicated structures. As the number of metals making up a eutectic alloy is increased, the freezing point of the alloy is further decreased. Tin, freezing at 456 degrees, Fahrenheit, forms with lead, bismuth, and cadmium, all freezing at higher temperatures, a eutectic alloy freezing at 158 degrees. Such an alloy melts in hot water and is often used in fire sprinkling systems. If a fifth metal, indium, is added to the other four, an alloy melting at 116 degrees or in luke-warm water, is obtained.

There is one type of alloy which does not fit well into the framework we have set up, and we cannot pass it by without mention. It is the type of alloy known as an intermetallic compound. Just as hydrogen atoms may unite with oxygen atoms to form molecules of the compound, water, so atoms of some metals may unite chemically with those of other metals to form intermetallic compounds. It is in these alloys that the number of electrons present per atom plays the important rôle. Metals in which the atoms have but one or two outpost electrons unite most readily with those in which the atoms have five or six of these electrons. This type of union tends to destroy, in a large measure, the metallic properties and such alloys are hard and brittle, and conduct heat and electricity poorly.

Closely related to such alloys though not usually classed as alloys are the compounds formed between certain metals and sulfur. Many of these, such as iron sulfide (fool's gold) and lead sulfide (galena), have a decided metallic luster. But further consideration of this vast and lightly explored field would carry us far beyond this brief survey of alloys.

We have considered two extremes: those in which the atoms are most similar, the solid solutions, and those in which the atoms are most dissimilar, the eutectic alloys. Between these extremes lie the interesting intermediate alloys. Suppose we consider two metals whose atoms differ somewhat in size but crystallize on the same pattern and are in other respects quite similar. We are now, in effect, trying to slip a larger atom into a hole in a crystal lattice designed for a smaller atom, or vice versa. The fit may not be perfect, but it may work within limits. We may put a few ostrich eggs into an egg crate designed for hen's eggs without destroying the total symmetry of the egg containers, but there will be awkward bulges in the partitions and if the process is continued for long we might better reverse the method and place hen's eggs in containers designed for ostrich eggs. Only within limits can these unlike objects be interchanged.

SO, too, in crystal lattices of metals, larger or smaller atoms may be substituted in the lattice within limits. But the substitution distorts or strains the crystal. It loses its softness, its malleability and ductility (Figure 16). When the distortion has proceeded to the limits of strain, there will come an abrupt change in the lattice; it may become that of the other metal. With this abrupt shift in the lattice comes an equally abrupt shift in the properties of the alloy, thus accounting for the sudden changes in the properties of alloys when the proportions of the two metals are but slightly altered. We are in effect changing suddenly from putting ostrich eggs into a hen's egg crate to putting hen's eggs into an ostrich's egg crate.

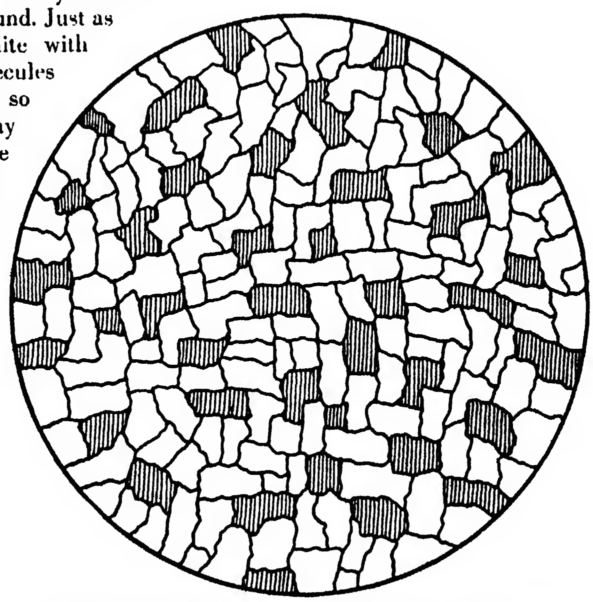


Figure 15: **How the structure of a eutectic alloy appears when seen under the microscope. Etching reveals the tiny crystals of the separate metals in it**

It is not always the case, however, that the crystal structure changes abruptly from that of the smaller atom to that of the larger or vice versa. There may be an intermediate structure which will best

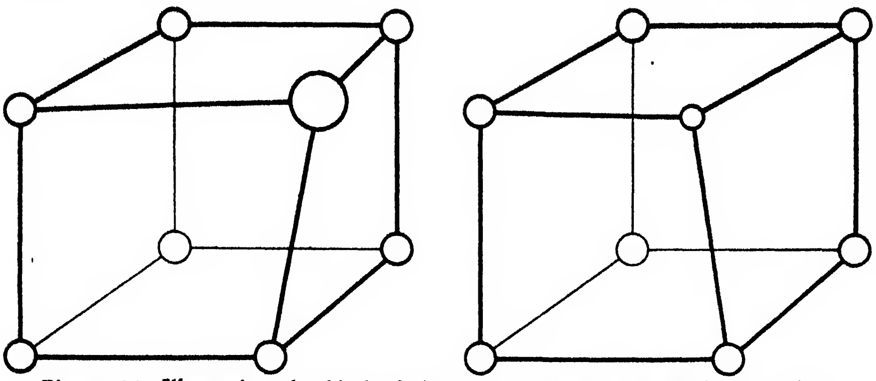


***Figure 16:* Illustrating the kind of distortion caused in crystal lattices when larger (left) or smaller (right) atoms of another metal are substituted in them**

accommodate the two sizes of atoms. Or there may even be several intermediate structures but the change from one to the other is an abrupt one. As we add more of one metal to another there may first occur a warping or distortion of the original lattice followed by an abrupt shift to an intermediate structure and ending finally in the distorted lattice of the added metal. One or more intermetallic compounds may even be formed in the process. These are the complicated alloys which still have the modern metallurgist scratching his head and wondering if he really knows what makes alloys behave as they do. Nevertheless, daylight is slowly but surely beginning to send its diffused rays into dark places to reveal nature's principles in the formation of alloys.

IN cases where one metal crystallizes on one pattern and the second metal on another, even though the atoms are similar in size and other characteristics, the story is much the same as that just related. The crystal structure is warped by the addition of the foreign atoms, then changes abruptly to an intermediate structure or to that of the second metal (Figure 17). Again an abrupt change in properties accompanies the change in structure. Alloys of nickel with chromium show such an abrupt change from the nickel lattice to the chromium lattice or vice versa. The nickel lattice can accommodate, without too great distortion, large numbers of copper atoms, hence the nickel-like appearance of copper-nickel alloys.

Since the substitution of any foreign metal atom in the lattice of a given metal invariably results in some distortion, some strain of structure, and some reduction of symmetry and slip planes, alloys of a given metal are invariably harder and less ductile than the pure metal. Pure silver is far too soft for coinage purposes; it is therefore hardened by alloying with copper.

The hardening effect of a trace of carbon on iron in steel making is noteworthy. Less than 1 percent of carbon present in iron increases the hardness and tensile strength many times over. This striking effect is thought to be due to the very small size of the carbon atom, which can fit itself into the iron crystal lattice without disturbing the iron atom formation. Instead of substituting for an iron atom, it merely slips in between iron atoms giving a so-called interstitial lattice formation (Figure 18). In effect, the addition of the carbon atom has stretched the lattice slightly, thus providing hardness without warping, and serves as an extra brace to the crystal, thus providing greater tensile strength.

It would be interesting to know, were the evidence available, just how much difference there can be in the sizes of atoms before substitution in a lattice becomes impossible. With such information at hand we should be able to predict whether a certain alloy should be of the solid solution or eutectic type. Dr. Hume-Rothery has recently studied this problem in a long series of experiments. His conclusions are that there must be less than 14 percent difference in the radii of the metal atoms for substitution to take place. If the difference is greater, there is no substitution in the lattice and the eutectic type of alloys can be expected. Obviously, the rule would hold only where other factors, such as number of electrons per atom and type of crystal lattice, do not interfere seriously. But the study is significant, in that it provides some quantitative means of predetermining the character of an alloy.

The principles upon which the formation of alloys depend have been touched upon but lightly; the details are too complex to consider here, and many problems remain to be solved. Few metals are ever 100 percent pure, and a trace of impurity may greatly alter the nature of the metal. Furthermore, most commercial alloys today contain not two but three, four, or more metals. Before we can have a complete understanding of these complex systems, we shall have to go much farther along the road of purposeful experiment. But the fact that we are beginning to understand even the simplest alloys—those composed of only two metals—is in itself heartening.

THE day will undoubtedly come when alloys can be built to order; when specifications can be met by first considering the principles involved, then building the alloy to meet its particular requirements. When that day arrives, countless new alloys will take their places in the industrial world, the home, the automobile, the airplane, and the train. The business of alloy building will have passed from the dark mysteries of trial and error technic to the bright stage of a true science. The alloy age of today is but a feeble ancestor to the alloy world to come, and our children will smile as they look back on a period called by enthusiasts, "the age of alloys."

(*The End*)

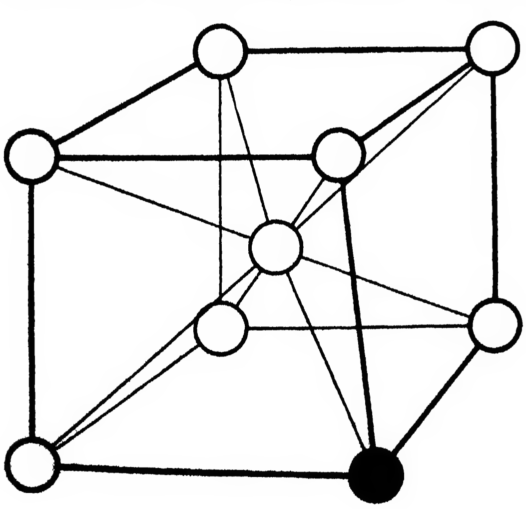


***Figure 17:* Distortion of a body-centred lattice by introduction of atom tending to crystallize in some different lattice structure**

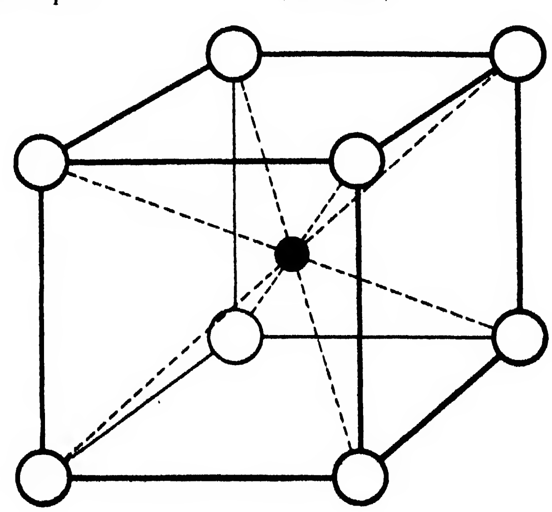


***Figure 18:* Interstitial lattice in which a small atom may enter the lattice of larger atoms without replacing one of the latter or materially disturbing the larger lattice**

ELECTRICITY PAINTS A PICTURE

. . . And the Picture Tells a Significant Story to Research Workers in Many Fields . . . Cathode-Ray Tube Development Has Made this Possible

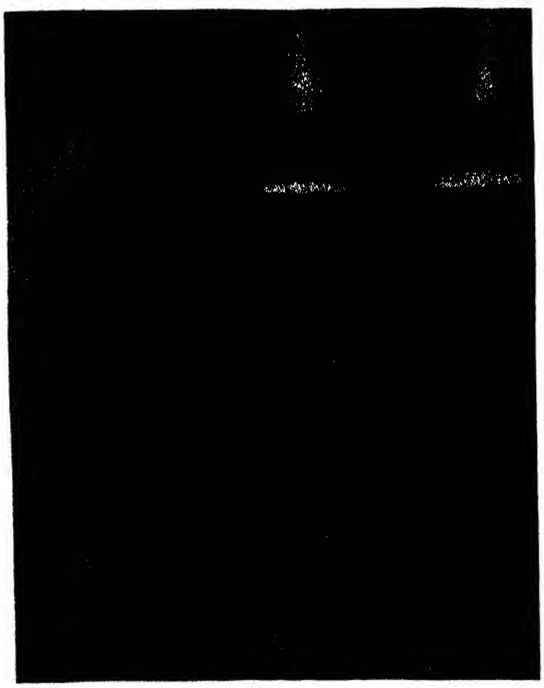
By ALLEN B. DUMONT

WITH an electronic beam for its brush and a fluorescent screen for its canvas, electricity can paint images of its own minutest variations, its lightning-fast changes, and its most complex moods. Devoid of the moving parts and inherent inertia of even the most delicate meter, the cathode-ray tube has become a new and startling tool in the hands of scientists, engineers, industrialists, and even radio servicemen, for applications and possibilities limited only by their own ingenuity.

Strangely enough, the cathode-ray tube is at once a very old idea and a very new application. Its origin dates back several decades. Various workers in the early electrical art, including Edison and Crookes. were aware of strange discharges of then unknown character in vacuum. But the commercialization of the cathode-ray tube really began with the experiments of J. J. Thompson in 1897 when he first discovered the true nature of the electron, and with the helpful work of Braun in the same year.

The usual cathode-ray tube is a funnel-shaped glass tube, highly evacuated. Indeed, the vacuum is so perfect that the larger tubes are subjected to such elevated atmospheric-pressure strains that it becomes necessary to resort to glass walls as much as ¼ of an inch thick, and rounded rather than sharp corners. The narrow neck portion of the conventional cathode-ray tube contains the electronic gun and its controls, while the chemical coating for the fluorescent screen is placed on the inside surface of the flared end.

The electronic gun contains a heated cathode which emits a copious flow of electrons, a modulating electrode surrounding the cathode for controlling the beam current, a focusing electrode for concentrating the beam, and an accelerating electrode which causes the electrons to be drawn out of the electronic gun at such tremendous velocity that they traverse the entire length of the tube and strike the fluorescent screen at the far end. The crystals of the fluorescent screen become agitated and throw off a bright glow at the point of impact. Thus there is, in effect, a veritable gun shooting a stream of invisible bullets which, upon striking a screen, cause a glow. Just a bright dot appears on the screen. Varying the voltage on the modulating electrode causes that spot to be brighter or dimmer; varying the voltage on the focusing electrode causes the spot to become smaller or larger. But as in the case of any gun, it is necessary to be able to aim the electronic gun —to swing it from left to right, and from top to bottom. This may be done by means of electromagnetic coils placed over the neck, on the outside of the tube. Or, what is the more common and popular method of deflection, deflector plates may be placed inside the neck of the tube, very close to the cathode beam as it passes between such plates from cathode to screen. Two sets of plates are required for vertical and horizontal displacement. The plates are, of course, at right angles to each other.



Cathode-ray tubes in the making. Minus bases, the tubes here are undergoing bombardment and final exhaust pumping before sealing off

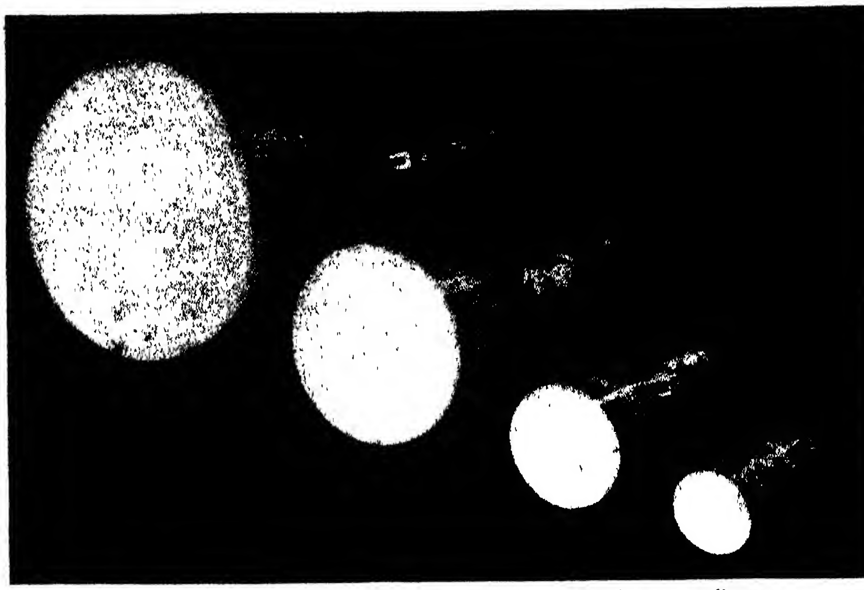
Now the beauty of the cathode-ray tube is the absence of moving parts or mechanical operation. Everything is done electrically, with the help of fluorescent chemicals. There is no weight or mass or inertia to contend with. The cathode-ray beam is as light as a light beam; it is weightless. It is capable of gyrating with lightning-like speed and of responding to the slightest variations in the electrostatic charges placed on its deflecting plates. The relative response of the cathode-ray tube and the usual indicating meter would be on the same scale as the acceleration of today's 12-cylinder automobile compared with the "one-lunger" horseless carriage at the turn of the century.

THE fluorescent screen plays a most important part. It is to the cathode-ray tube what a sketching tablet or canvas is to the artist. No amount of swinging of that practically invisible cathode-ray beam could create an image unless those fluorescent crystals were ready to glow on impact and, what is equally important to the case, to continue glowing for a longer or shorter interval, depending on the use of the tube, thereby producing the effect of a complete image or pattern rather than just a dot of light. The user today has the choice of fast or slow fade-out of the fluorescent image, or so-called "decay" rate. For photographic purposes, a relatively high decay rate is used, while for television's images, a slower decay rate to reduce flicker is more desirable.

A plurality of panel controls have to do with the operation of the cathode-ray oscillograph. The controls on the left side may affect vertical motion of the cathode beam, those on the right affecting horizontal motion. If the left positioning control is moved slowly, the cathode-ray spot moves up and down as a dot. If the positioning control is wiggled rapidly, the dot becomes a continuous line. By turning the right positioning control, the spot can be shifted horizontally, while a wiggle results in a horizontal line. Wiggling the two positioning controls produces diagonal lines and even circles.

The most general use of the cathode-ray oscillograph employs displacement along the horizontal in proportion to time. A device for producing such displacement is termed a linear sweep circuit, and the rate of this sweep can be adjusted quite critically to simplify the observations being made.

Reduced to simple terms, and essential for a real understanding of the cathode-ray oscillograph, the operation is as follows: An electrical input voltage proportional to the quantity to be measured, either mechanical or electrical, is applied at the vertical input terminals. Suppose a low-voltage, 60-cycle signal is connected to the vertical posts. With the "sweep" turned off and only the vertical amplifier turned on, the input signal gives a convenient length vertical line.



Typical cathode-ray tubes, from nine-inch to two-inch screen diameter

Wave-form of an alternating current is painted electrically on the round screen of a cathode-ray tube

Note that using just one set of deflector plates gives just an up and down or straight-line image. If now the sweep circuit is turned on, the straight line instantly wiggles into a series of waves. These may be quite narrow, steep, crowded together. A further adjustment of the sweep circuit stretches them out, broader, but not so many showing within the circle of the screen. The sweep circuit may be adjusted so that the waves glide slowly by, to the left or the right, or even stand absolutely still. Even a portion of a single wave may be obtained, greatly magnified, for critical study. With electricity painting its own picture, anything which can be translated into electrical terms can be critically studied with the oscillograph.

Until a half-dozen years ago, the cathode-ray tube was a comparative rarity. Today tens of thousands of cathode-ray tubes, ranging in diameter from two inches to nine inches, are in daily use. Quickly surveying the radio field it is found that even the radio serviceman with a slim purse now boasts a cathode-ray tube oscillograph to aid him in tracking down the most persistent radio troubles. Radio factory workers use cathode-ray tubes for testing and adjusting sets and components.

IN the more refined cathode-ray tube, already available, is the basis for practical television reception. With satisfactory associated equipment, the cathode-ray beam reproduces the necessary pattern of glowing lines to match the pick-up scanner at the remote transmitting studio. A modulating electrode in the tube serves to vary the intensity of the spot, and this variable intensity, plus the sweeping of the dot line-by-line for a total of 441 lines representing our present scanning standard in America, weaves a picture on the screen.

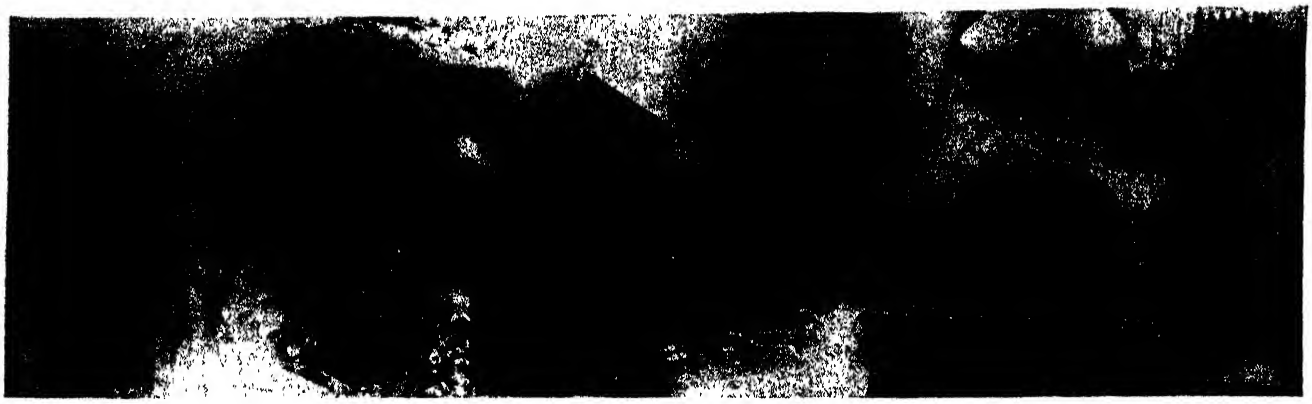
But the cathode-ray tube does not stop with radio and even with early television. Every day, so it seems, new and unexpected applications turn up. In the field of music, for instance, the resonoscope is a development which is producing an entirely new pitch consciousness. Here is an instrument which provides for the first time a definite standard of musical pitch and then tells you how near you can approach that pitch with your voice or musical instrument. [The resonoscope was described on page 105, February 1938 Scientific American.—Editor.]

Other human queries are answered by the cathode-ray tube. For example, it can be used as a highly sensitive electrocardiograph, or heart tester. The slightest tremors can be greatly amplified and magnified on the screen, studied and photographed. The results of nervous disorders and reflexes may be sketched on the screen. The electro-encephalograph provides five simultaneous indications of five brain, nerve, or reflex conditions of a patient on five different cathode-ray tubes. It is entirely probable that the veracity of witnesses in the future will be decided by the wiggles on the cathode-ray screen of a lie detector.

Because the cathode-ray tube is lightning-fast in its response to the slightest electrical variation, it finds no end of uses in studying either recurrent or transient phenomena. It is used in studying what is happening in all kinds of electrical circuits. Wave forms are traced in simple or intricate patterns on the greenish fluorescent screen, which keep on reproducing themselves so long as the electrical phenomena take place.

In the case of transient phenomena, a slow-decay fluorescent screen is used, producing a bluish image. A single impulse of the desired transient phenomenon is fed to the oscillograph. The corresponding pattern is instantly traced on the screen and remains "frozen" in place for a full minute or more, slowly fading away. Several transient phenomena can be flashed on the same screen, and comparisons made because of the slow decay rate. This ability to hold patterns is of tremendous importance in studying such lightning-like phenomena as the operation of circuit breakers, the breakdown of electrical condensers, the action of automobile distributors, and so on.

The cathode-ray tube, in the final analysis, is a sort of finger-print expert. Everything in this world has characteristics peculiar unto itself. If those characteristics can be reduced to electrical terms, then those electrical terms become the veritable finger prints which the cathode-ray tube reproduces for critical visual study. Hence its industrial applications are practically unlimited.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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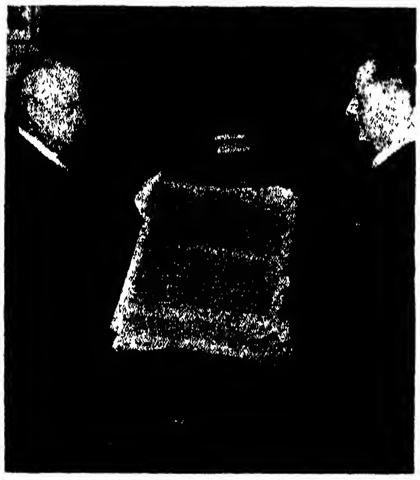
Chemical Engineer

6000 Years Hence

IN our photograph, C. M. Broome, Jr., representative of The American Rolling Mill Company (left), presents Dr. Thornwell Jacobs, president of Oglethorpe University, Atlanta, with a stainless steel plaque for the door of the crypt in which comprehensive records of present civilization will be preserved in stainless steel containers.



Presentation of the metal plaque that will seal for 6000 years the crypt containing civilization's full record

The crypt, to be sealed next year, will not be opened until 8113. Dr. Jacobs first announced this plan in detail in the November, 1936, issue of Scientific American.

The plaque, bearing the names of President Roosevelt, former Governor Talmadge of Georgia, and Dr. Jacobs, reads:

"This crypt contains memorials of the civilization which existed in the United States and in the world at large during the first half of the twentieth century. In receptacles of stainless steel, in which the air has been replaced by inert gases, are encyclopedias, histories, scientific works, special editions of newspapers, travelogues, travel talks, cinema reels, models, phonograph records and similar materials from which an adequate idea of the state and nature of the civilization of 1900 to 1950 can be ascertained. No jewels or precious metals are included.

"We depend upon the laws of the County of DeKalb, the State of Georgia and the Government of the United States, and of their heirs, assigns and successors, and upon the sense of sportsmanship of posterity for the continued preservation of this vault until the year 8113 at which time we direct that it shall be opened by authorities representing the above governmental agencies and the administration of Oglethorpe University. Until that time, we beg of all persons that this sealed door and the contents of the crypt within may remain inviolate."

CANE

A TON of sugar cane will yield approximately 100 pounds of raw sugar and three gallons of rum. ***—Industrial and Engineering Chemistry.***

Repelling Rodents

TO reduce the loss of fall-planted bulbs commonly experienced by gardeners through the ravages of rats and other rodents, a new compound with a slight odor has been developed. Its odor is not unpleasant to human beings but drives rodents away so that they do not eat parts of bulbs treated with it. It is non-toxic and is applied to the bulbs before planting in the fall.—*D. H. K.*

Explosimeter

THE M. S. A. Explosimeter, a pocket-sized instrument for quickly and easily determining the presence of combustible gas hazards, has been placed on the market by Mine Safety Appliance Co.

This instrument is designed to meet the demand for an instrument that can be carried about on the job and operated by any workman. It shows whether gas concentrations are within or above the explosive range. In size and weight, the Explosimeter compares with a small folding camera, and can be carried either in a pocket or on a shoulder strap.

By operating a small piston-type pump, a sample of the atmosphere to be tested is drawn through a length of hose into the Explosimeter. Sampling line of practically any length may be used, with no lag in the indicator reading except the time required to draw the sample through the line.

The gas sample flows over a hot platinum wire which forms a part of a balanced electrical circuit, current for which is provided by a small two-cell dry battery. This detector unit is balanced against the filament of a small electric light bulb burning in an inert atmosphere. Combustion of gases on the surface of the detector filament creates an increase in the temperature of the wire and consequently an increase in its resistance, thus causing the electrical circuit to be unbalanced. This unbalancing of the circuit causes a deflection of the pointer of the electrical meter, proportional to the concentration of gas in the atmosphere being tested. The concentration of gas may be read directly on the meter, which is graduated in percent of the lower explosive limit.

Adjustment of a single knob is all that is necessary to prepare the Explosimeter for use and to maintain it in operating condi-

Detecting combustible gas

tion. This single control is used to turn the instrument on and off, balance the electrical circuit, and indicate the extent to which the battery in the instrument has been consumed.

Some of the fields in which the Explosimeter is now being used include distilleries, public utilities, oil refineries, paint and varnish plants, iron and steel mills, chemical by-product plants, and so on. It is especially well adapted to use by municipalities for investigating fire hazards and gas hazards in sewage disposal plants.

House That Research Built

REVOLUTIONARY changes in the design and construction of industrial buildings through the liberal use of sheet iron and steel instead of conventional materials were demonstrated in Middletown, Ohio, recently by The American Rolling Mill Company at the dedication of its new research building.

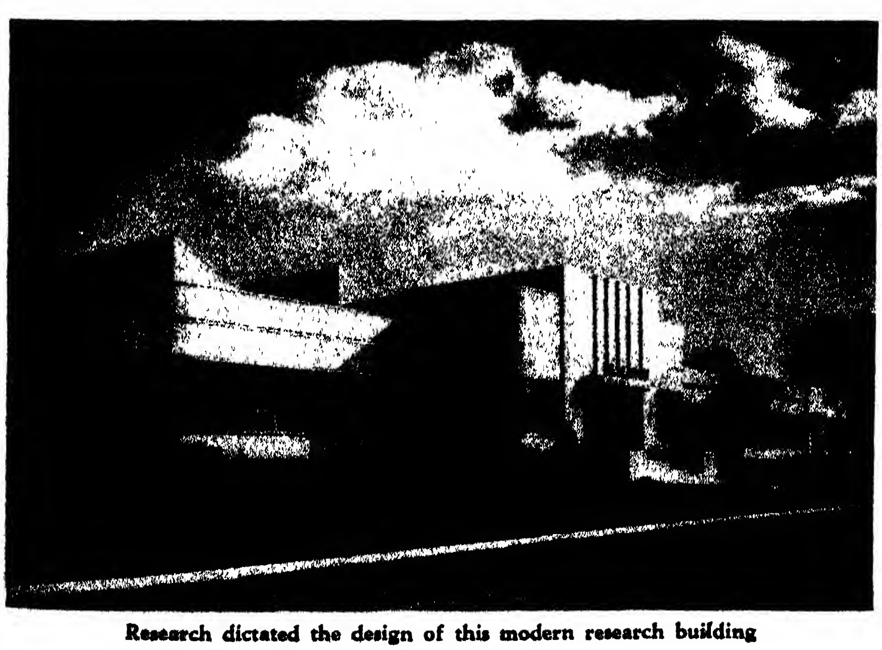
Dr. Anson Hayes, Armco research director, said the building was erected after extensive investigation to prove the practicability of the use of sheet iron, sheet and strip steel, and stainless steel in building construction. Six different types of iron, steel, and stainless steel were employed. There is not a rivet in the entire building, the walls being fastened to the structural frame with electric welds.

The extent to which use of new materials and the new designs they make possible can change building architecture is emphasized in the new laboratory building by the elimination of sharp corners which give way to graceful arcs. Horizontal bands of cream-colored porcelain-enameled sheet iron sweep uninterruptedly across 600 linear feet of front and side walls, accentuated by bright strip-moldings of stainless steel. Black porcelain-enameled pilasters separate the lighting bays, which are filled in with opaque glass block, into which are set steel frames to hold the window areas of clear glass.

The interior walls also are of sheet steel, highly finished in imitation wood patterns. The building is wrapped in a three-inch blanket of insulating material, spread between the interior and exterior wall sections.

A daylight interior is achieved with a roof of special saw-tooth design faced with glass block. The acoustically-treated roof deck is made of galvanized sheet steel, rock, cork, and asphalt. A combination system provides heat in winter and complete air-conditioning in summer. Because of the compactness of the welded joints and the efficiency of insulation, it is anticipated that great economies in heating and cooling will be realized. There are approximately 100 laboratories, offices, conference and reception rooms, with ample storage and receiving space.

Engineers say the building is as near 100 percent fireproof as it is possible to be. It was erected by the Austin Company of Cleveland. Harold Goetz of Middletown, Ohio, was associate architect.



Research dictated the design of this modern research building

PLATES

THERE is an increasing tendency to jumble numbers and letters together on automobile license plates. It is well-known, however, that the most legible grouping of six-digit license plate numbers would be by twos and threes without an additional letter or two to confuse.

"Natural" Portrait Photography

FINER lenses and faster films long ago eliminated the head rack which was used by old-time photographers to hold the "patient's" head while his portrait was being made. Nevertheless, most portraits still have a stiffness, a lack of life-like quality because posing is still the fashion in most photographers' studios. Such is not the case when Polyfoto equipment, which comprises the adaptation of the candid camera to portrait work of a different kind, is used in the studio.

Polyfoto is a candid camera on wheels. Employing all the features of fine lens equipment, automatic shifting of negative surface, range-finder focusing and precision manufacture, it is a specialized patented device for making natural portraits of people and pets. Mounted on a movable base with rubber-tired wheels, it is operated within a studio in conjunction with standard lighting equipment and makes 48 different exposures of the subject on one small negative plate. These tiny negatives are "blown up" in precision enlarging cameras and the finished portraits of any desired sizes up to three feet square are delivered to the purchaser.

A few of the 48 exposures made in sequence with new Polyfoto camera

Its advantages over conventional methods are numerous, but the outstanding one is naturalness of pose. Polyfoto operates so rapidly and so many exposures are made that no sitter is ever asked to hold a pose. She is put at ease by the photographer, he converses with her, she falls naturally into relaxed positions, her expression becomes interested, animated, mobile. As these fleeting expressions come and go he flips a handle; each exposure is made instantaneously and the negative is moved automatically to the next taking position. Exposures can be made as rapidly as two per second or as slowly as the photographer chooses. Every one is under his control. Consequently, out of the 48 separate poses at least one favorable picture is certain to be found. Usually there are several.

These 48 poses are enlarged on a single sheet, for the purpose of guiding selections for enlargements.

Milk in Foundry Cores

A NEW binder for the sand used in making cores for foundry castings is made from the solids of milk of a non-edible grade. This binder holds the sand together until the metal has solidified but burns off, leaving the sand clean for re-use.—*D. H. K.*

Highway Killers

IN a report delivered before the Society of Automotive Engineers, Mr. Charles A. Hartnett, New York State Commissioner of Motor Vehicles, expressed the belief that "Speed too fast for conditions is the highway's hungriest killer," according to the Associated Press. He included tabulations

of the opinions expressed by 42 members of the American Association of Motor Vehicle Administrators based upon their personal experience and observations. Of these administrators—

Thirty-four believe present brake performance to be satisfactory.

Thirty-three said headlights were unsatisfactory; 20 favored the three-beam position—city driving, passing, open country.

Twenty-seven advocated high mounting of the tail light.

Sixteen favored the blinking type of stop light; 22, the steady dual stop light.

None believed cars had insufficient speed.

Twenty-three opposed use of speed governors; 12 favored them.

Twenty-nine opposed elimination of running boards.

Thirty-four favored recessing the choke, throttle, light switches and ash receivers; 37, recessing the robe rail hardware.

Nineteen considered the driver's seat too low for adequate visibility; 17 thought it was not; 26 believed the hood too high.

Forty-one expressed the view that dual windshield wipers and some form of defrosting device should be standard equipment.

Fourteen felt a radio was distracting to the driver; 21 disagreed.

Mr. Hartnett said he believed a three-color speedometer face—green for up to 30 miles an hour, amber from 31 to 50, and red above 50—"would have a psychological effect on the driver."

Mock-Ups

THE most careful engineering has gone into the construction of the huge Boeing Clipper flying boat, and "mock-ups" or dummies of various parts of the seaplanes were built in most elaborate fashion. Made of Douglas fir plywood covered with muslin, these "mock-ups" were to full scale and in complete detail and serve the most useful purposes. For example, simulation of the pilot's cockpit enables the designers to test out the working of the controls, the convenience of the instrument board, and so on. A plaster of Paris cast of the hull shown in one of the photographs was used in the process of making zinc dies for drop-hammer work. The drop hammer and huge hydraulic presses are now freely used in aircraft production and have completely displaced the bumping out of metal sheets by hand.—*A. K.*

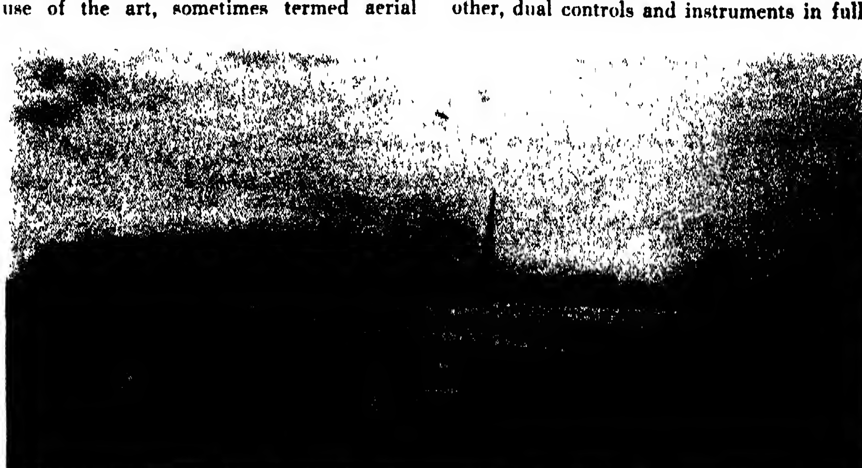
Above: **Plaster of Paris cast being made of clipper-ship hull. From this cast will be made dies for drop-hammer work.** ***Right:*** **Mock-up of pilot's compartment for studying controls and location of instruments**

Mapping from the Stratosphere

AERIAL mapping had its birth in the World War, when it was introduced as an aid to military reconnaissance. Now it has become an aid to innumerable peacetime activities. Government agencies utilize aerial mapping in studies of flood control, soil erosion, crop planning, navigational improvements, water power developments, highway location, city planning, and other important projects. Private industry makes use of the art, sometimes termed aerial photogrammetry, in the development of coal and oil fields, in timber surveys, real estate planning, water and power distribution. Aerial mapping formerly was undertaken at relatively small heights; today it is venturing almost into the stratosphere, for two reasons—the greater the height, the greater the area of terrain which may be photographed in a given time; second, the greater the height the smoother the air and the steadier the aircraft, which is, of course, a real help in accurate work.

To keep pace with the growth of the art, and the improvement in technique and camera equipment, a special photographic airplane has been designed, built, and successfully test-flown by the Abrams Air Craft Corporation. The new plane, termed the "Explorer," is illustrated in one of our photographs. It differs in appearance from more conventional airplanes, because it has been designed on a strictly functional basis —although no sacrifices in efficiency have been made.

One of the foremost requirements of the mapping plane was to give the pilot perfect visibility forward and downward for precise location flying. This objective was achieved by making the airplane a "pusher" and seating pilot and camera-man in a glass-enclosed gondola projecting far ahead of the wings. The next requirement of very rapid climb was achieved by loading the wings rather lightly and supercharging the engine. Since the camera-man may have a long job to do, and accuracy is greatest when photographs are taken in a single flight, the flying endurance has been made large and the "Explorer" is capable of eight hours flying at cruising speed. So that the crew can be perfectly at ease at great altitudes for a long period of time, the glass-enclosed gondola has been hermetically sealed, and special oxygen equipment has been provided. Again, so that pilot and camera-man may relieve each other, dual controls and instruments in full



High-altitude aerial mapping gave birth to this novel plane design

The camera registers the landing curve of a transport plane

view of both men are a feature of the installation.

An additional photographic feature is what the constructors have called a "door within a door." This allows the cameraman to sit in his regular seat and, without opening the main outer door, to take pictures at oblique and forward angles. A mapping porthole with a special camera mount is provided in the floor of the gondola, and the aperture is hermetically sealed when the camera is in place. The interior has been made compact to minimize the oxygen supply requirements.

Our readers can judge for themselves of the streamlining and general neatness of the craft. The pusher arrangement necessitates the carrying of the tail surfaces on two booms. The new type nose-wheel landing gear which prevents nosing over and facilitates side wind or drift landings has been very logically incorporated in the design. The gross weight of the ship, fully loaded and equipped, is only 3200 pounds. With a Wright R 975-E engine, developing 350 horsepower at 2100 revolutions per minute, and appropriate supercharging, the speed at 10,000 feet is 200 miles an hour. The service ceiling is 21,000 feet, and the initial climb is extremely rapid—1800 feet per minute. —*A. K.*

Photograph of a Night Landing

WE believe that the accompanying photograph of the landing of a United Airliner at night is the first of its kind. The "candid" camera is registering a landing at the Chicago Municipal Airport after a non-stop run from New York. The twin white lines cast by the two landing lights on the wings of the plane clearly define the path followed by the pilot, and show how the glide is converted into more or less horizontal travel a few feet above the ground. —*A. K.*

World's Largest Naval Patrol Bomber

THE experimental bombing plane, *XPBS-1*, developed and built by Sikorsky Aircraft for the Navy Department, is remarkable in many respects, and is a valuable addition to national defense.

It has enormous range, high speed, and the ability to function as an independent unit. Further, it will have a bomb load comparable with that of any known land plane. Armament will consist of bow, rear, and center gun turrets.

Among noteworthy features in design are a gross weight five or six tons greater than in any commercial Sikorsky flying boats, and the elimination of bracing structure to give a full cantilever high-wing monoplane. The design and construction of the huge patrol boat required two years and hundreds of thousands of man hours in the engineering office, the drafting room, and the shop. The "mock-up," a model in wood and fabric of the finished article, took six months' work in itself. The four twin-row Wasp engines, incidentally, are of 1050 horsepower each. There is no attempt to make the *XPBS-1* an amphibian, but a beaching gear, as shown in the photograph, is carried on board to facilitate beaching, docking, or ramping.

What is perhaps most striking in the new machine, however, is the further development of facilities which make the flying boat as comfortable to live in and as completely equipped as a naval surface vessel. Thus, a complete radio compartment is installed, comparable with that provided in a destroyer. The crew's quarters include comfortable living accommodations, a mechanic's workshop, galley with electric stove, a water distiller, and a dry-ice refrigerator. Hitherto the electrical equipment on aircraft has been actuated by 12-volt batteries, or by a generator driven from the main engines. The Sikorsky provides an innovation which may be of the utmost practical importance; namely, the installation of a complete 110-volt electrical system, driven by an auxiliary gasoline engine and supplying power for all the electrical units such as flap actuators, anchor winch, radio, lighting, heating, bomb controls, galley, and so on. There are obvious advantages in lighter weight and greater reliability when a 110-volt generator is substituted for a 12-volt battery. Also, the electrical system, since it has an auxiliary engine as the prime mover, can continue to function even when the main power plant is out of commission. Another useful feature, recalling surface vessel practice, is the complete telephone system which makes communication possible from any point of the airplane from the extreme tail to the bow, with thousands of feet of electrical wiring carried in light conduits and through junction boxes.—*A. K.*

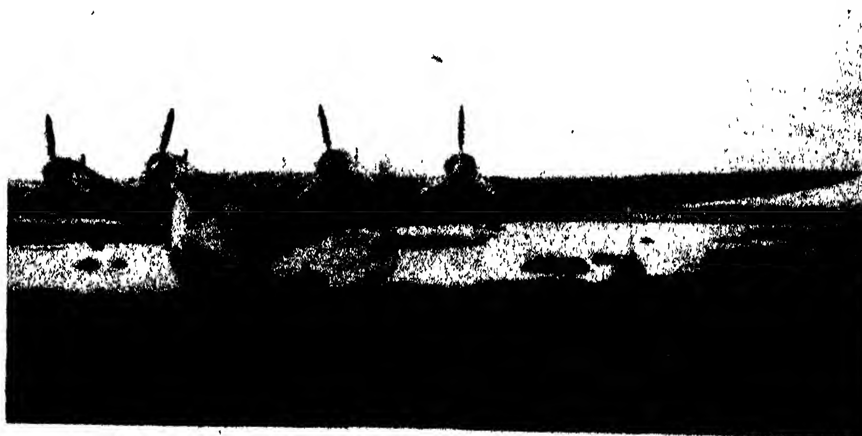
Inventions in Aircraft Radio

WRITING in *Aero Digest,* Henry W. Roberts makes some valuable suggestions for inventors and engineers interested in the field of aircraft radio. He describes what he calls "Inevitable Inventions" and argues that such inventions are logical in conception and feasible in execution, with the knowledge already available. These suggested inventions are:

An absolute altimeter using radio waves transmitted from the aircraft and reflected by the ground. Ultra-high-frequency short waves would be employed and automatic continuous indications of absolute altitude would be given by use of a cathode-ray tube arrangement. Such a short-wave apparatus would be immune from the vagaries of the atmosphere which vitiate the readings of the barometric type altimeter. There are many technical difficulties involved, but no impossibility in principle.

A radio-controlled Gyropilot for commercial use. Successful radio-controlled flights for military purposes have been made in half-a-dozen countries, and dozens of radio-controlled boats have been constructed by radio amateurs. It is theoretically possible to navigate an airplane by radio, from take-off to landing, by any of the three methods of radio navigation—radio range beacons, airplane direction finders, or ground-direction finders—and to bring the ship to its destination without collision with ground obstructions or other aircraft. At present the density of aircraft traffic does not warrant such complicated mechanization, but who knows what will be needed as air traffic steadily increases?

A radio drift indicator might be improvised by combining the readings of an aircraft radio direction finder, capable of bearing indication in degrees, with the readings of the directional gyro. Rudder correction



Not an amphibian, the XPBS-1 carries a beaching gear on board

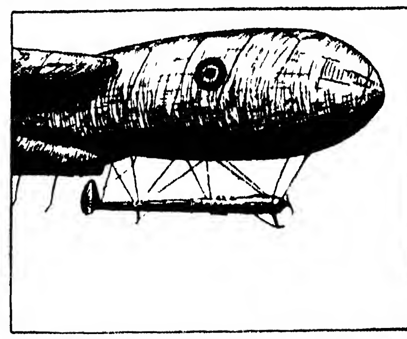
would be applied until there was no divergence between the two.

Mr. Roberts also outlines new types of radio marker beacons with which experiments are already being made, and suggests the revival of electromagnetic guide cables when flying over particularly difficult terrain.

In spite of the manifold advances already achieved in aircraft radio, a fruitful field of invention still remains. —*A. K.*

Motorized Observation Balloons

Captive balloons have played useful wartime rôles in observation, in the guidance of artillery fire, and in many other ways. They have often been shot down, and have suffered extensively from their lack of mobility. Hence, military opinions both in the United States and in European countries have veered to favor motorized observation balloons; it is an open secret that



Kite balloon with motorized fuselage

motorized balloons have been built for our own Army Air Corps, although pictures of them are not available. Hence the accompanying sketch of a motorized observation balloon exhibited at the "Air Infantry" show at Villacoublay, France, is of considerable interest.

It will be noted that the balloon itself is rather longer and more streamlined than is customary with stationary or kite balloons. Inflated lobes are still provided at the rear for stability, but instead of a simple observation basket, there is a suspended airplane type fuselage, with engine and propeller disposed in the conventional manner. No landing gear is provided—there is nothing but a peculiar form of landing skid. Since the motorized balloon can rise vertically or land vertically, wheels are not necessary. In fact, the motorized balloon comes very close to the combination airplane-airship which inventors advocate so frequently. It is doubtful whether there is anything to be gained by such a combination, however—except in the special fields of artillery observation, or possibly in forestry patrol and photographic work.—*A. K.*

Largest Hydraulic Press

Aircraft manufacturers find it more difficult than automobile manufacturers to keep down unit production costs because they do not build large quantities of airplanes of the same type in one year. But with the boldness of pioneers they do not hesitate to invest in the most advanced and most expensive production machinery. Thus, Douglas has purchased from the Hydraulic Press Manufacturing Company the world's

largest hydraulic press—it required nine 12-wheel flat cars to transport this giant piece of machinery from Ohio to California. The press stands four stories high, and weighs 840,000 pounds, with individual parts correspondingly heavy.

A battery of centrifugal oil pumps, variable and reversible in delivery, are driven by two 150-horsepower electric motors. These pumps deliver oil under 2500 pounds

Aluminum alloy parts for airplanes are formed in this hydraulic press

per square inch pressure to the six-foot ram, and a total pressing force of 10,000,000 pounds is the result. Hydraulic pressure is directly applied to the press rams without intervening valves. Thus there is obtained speed, delicacy of control, and complete reversibility. The maximum opening between platen and bed is four feet.

With this press it is possible at the same time to shape, form, and punch several unrelated aircraft parts at a single pressing. Three thousand different parts, all of aluminum alloy, will be pressed with this new equipment. Because of the methods employed, tool costs have been greatly reduced as compared with conventional tool methods.—*A. K.*

Fighting Deafness in the Air

We are indebted to Roger Humphreys for a first-hand account of a device of his own invention which will counteract temporary deafness induced by the impact of reproduced crashes of radio static when in flight. Mr. Humphreys, a pilot himself, has found that violent static has affected his hearing frequently, although temporarily. The original experiments were inspired by the fact that there are available, in commercial form, bone-conduction hearing devices. Ordinarily sound waves enter the outer ear, strike the ear drum, and are carried by a hammer-like device through the middle ear to the inner ear where the nerve centers pick up the message and transmit it to the brain. The new device short circuits the ear altogether. Sensitive, electrically charged diaphragms are attached on both sides of the head over the mastoid bone behind the ear. The two diaphragms are held in place by a light steel head piece. They may be applied with equal success but less conven-

ience on the cheek bones. Since no restrictions on electric power or appearance have to be studied, the flight "Sonotone" has been designed for great sound volume.

Flight tests have proved entirely satisfactory. Mr. Humphreys sets down a four-fold objective: 1, to provide means of hearing signals in severe static conditions; 2, to eliminate the probability of congestion of the middle ear with the attendant loss of hearing during rapid descents; 3, to prolong the usefulness of a pilot who is growing deaf through constant noise punishment; 4, to aid pilots in their old age by actually preventing deafness. No one can question the desirability of these objectives.—*A. K.*

FUSES

ONE utility company spends a quarter of a million dollars yearly replacing residential fuses.

NAVAL CONSTRUCTION

ALTHOUGH this is being written days later than the editorial on Naval Construction on page 137 of this issue, there still is no definite word as to what will be the extent of future construction. That we are committed to a definite increase over and above the plans of a few months ago is quite certain. This increase may reach as high as 20 percent although until the President, Navy officials, and Congress work out the details, one guess is as good as another. In view, however, of this increased activity it is well to review the status of naval building in this country as of December 1, 1937, the last available complete figures.

Of the two battleships which are to be completed in 1941, the *North Carolina* was laid down at the New York Navy Yard last October, while the second one, the *Washington*, is to be laid down at a later date at the Philadelphia Navy Yard.

The only aircraft carriers on the present schedule are the *Enterprise* and the *Wasp*. The hull of the former ship was 96 percent complete and the machinery 93 percent complete on December 1, and it should be commissioned this coming May. The *Wasp*, hull and machinery, was something under 50 percent complete and it should be finished in November of this year.

One heavy cruiser, the *Wichita*, was almost three-fourths complete and should be ready for commissioning by February, 1939.

Of the eight light cruisers which were on the ways one was finished in January, another was scheduled for completion in February, four others will be completed later this year, and the last two will be commissioned in 1939.

Sixteen submarines were scheduled on December 1, but of these the keel had not been laid for four although some work had already been done on their hulls and machinery. One of these four is scheduled for completion in 1939, and the other three in 1940. Of the remaining twelve, all in the process of construction, six will be completed in 1938 and six in 1939.

Until recently our Navy was sadly in need of destroyer flotilla leaders. Four 1850-ton destroyers are scheduled for completion this year, one as early as February.

Smaller destroyers of 1500 tons now scheduled total 32. Seventeen of these have not

yet been laid down but considerable work on the hulls and machinery has been done on nine of these and the entire seventeen are scheduled for completion in 1939. Four of the remaining fifteen now on the ways will be completed in 1938 while the final eleven, on some of which the work is rather far advanced, will be completed in 1939.

During the late fall of 1937 the light cruiser *Philadelphia* and the destroyers *Somers, Helm, Ralph Talbot,* and *Jarvis* were commissioned and delivered.

Water Resistance of Paints

OILS used in paint vehicles are useful because they exclude air and moisture from the protected surface. Recent investigations have shown that both the kind of oil used and the drier compounded with it affect the rate of penetration of the film by moisture. Linseed-oil films are more resistant to moisture when they contain cobalt driers than when lead compounds are used. The reverse is true of tung and oiticica oils which lead driers make more resistant to moisture than do cobalt compounds. The explanation of this effect is probably in the relative importance of polymerization and oxidation in the drying of these two different classes of oils. Linseed oil dries largely by oxidation, which is promoted by cobalt, and tung oil depends principally on polymerization, promoted by lead, to form its films.—*D. H. K.*

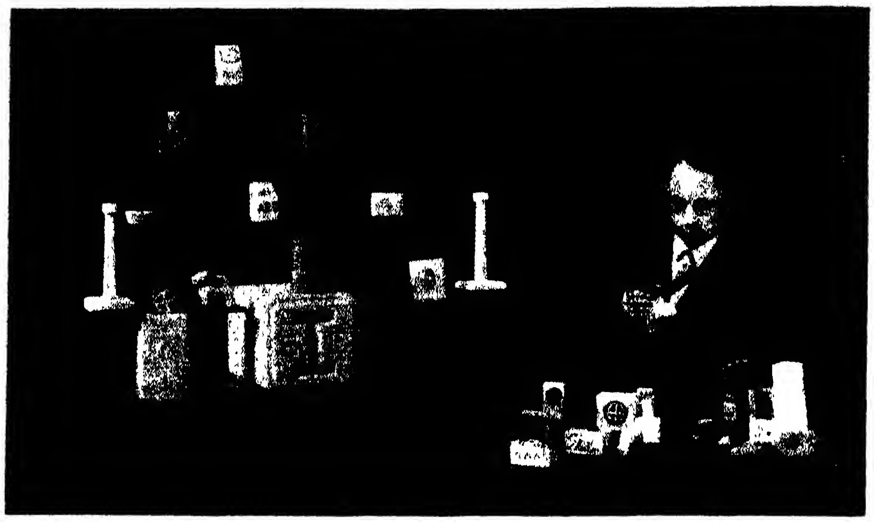
BERIBERI

YEAST, bacteria, mushrooms, peas, tomatoes, beetles, birds, goats, monkeys, rabbits, rats, mice, and men have all been shown experimentally to need the beriberi vitamin, vitamin B_1.

Safe Tool Steel

ANYONE who has occasion to do any hammer drilling or hand chisel cutting will realize how impossible it is ordinarily to keep the head of the drill from spalling or mushrooming under constant impact of the striking hammer. From the mushroomed head splinters of metal often fly into the eyes of the operator or cause jagged cuts. An appalling number of accidents are chargeable to such flying fragments of steel which strike vulnerable parts of the body. Another unsatisfactory characteristic of ordinary tool steel is the ease with which it may be burned under a tempering treatment. Nowadays it is difficult to find a workman who knows the art of tempering properly.

For the express purpose of putting an end to the dangers pointed out above and at the same time provide a steel that eliminates guess-work and simplifies tool making and tempering, research has finally developed a product revealing unique qualities. This new steel is Malga, an electric furnace tool steel. Because of its low carbon content and inclusion of molybdenum, tungsten, silicon, and manganese, Malga non-tempering steel forges easily within a broad range of high temperatures and is hardened simply by reheating to a salmon color and quenching



Carving salt brick ornaments offers possibilities as a home hobby

in water. No tempering is required after hardening; hence the most inexperienced mechanic can easily obtain perfect results. Malga is said also to maintain a keen cutting edge so that it bites into extremely hard materials without turning. It does not have a tendency to batter or chip; the danger of flying splinters due to mushrooming is eliminated.

TELESCOPE

IF the earth were flat, a 200-inch glass telescope reflector would permit a man in San Francisco to read a sign in New York as clearly as the New Yorker reads it from across the street.

Salt Sculpture—Another Hobby

A NEW hobby, carving in salt, has been added to the growing number of home hobbies. Sculpture in soap has cut a wide figure during the past few years, and now comes salt—compressed salt bricks of uniform texture. Incidentally, salt is even less expensive than soap.

L. R. GrosJean, of Watkins Glen, N. Y., hit on the hobby, no doubt because of two coinciding reasons: he uses tools in mechanical hobbies of other kinds and he has a very "considerable" amount of salt within arm's reach, since he is Manager of the large Watkins Glen plant of the International Salt Company, Inc.

What Mr. GrosJean uses in his carving is not natural rock salt but artificial rock salt made by submitting ordinary table salt to a pressure of 1000 tons, thus making bricks of it. Such bricks are not made especially for carving, but are the common product sold to ranchers and farmers for stock feeding.

The photograph shows how the carving is done—by means of a small rotary abrasive wheel driven by a high-speed electric motor, in this instance the Handee Tool. However, the salt may also be carved with ease by means of a jack-knife or other common tool.

Because the calcium chloride in the salt has been eliminated, the bricks are not hygroscopic and will not draw moisture from the air and become sticky.

Inlays may also be made. This is done by filling in the incised depressions or carvings with du Pont's or LePage's transparent cement having the consistency of putty, and then allowing this to set and smoothing off the surface with sandpaper. Or these may be filled in with cement made of loose salt, transparent cement, and dye of any desired color.

In the photograph, at the center of the left-hand group of carved objects, is a unique object, a salt saltcellar, no doubt the first made by anyone.

Low Temperatures Magnetically

TEMPERATURES close to absolute zero, a point 459 degrees below zero, Fahrenheit, and the theoretical low limit of cold, will be obtained by means of a powerful electromagnet described by Dr. Francis Bitter of the Westinghouse Electric and Manufacturing Company.

The magnet will be used to restrain the motions of atoms magnetically, Dr. Bitter explained. This will produce cold close to the absolute zero limit because of the fact that heat is nothing more than motion by the molecules. At absolute zero molecules and atoms have practically stopped vibrating. Magnetic restraint of the atoms can thus be used to achieve extremely low temperatures more easily than by liquefaction of helium.

Synthetic Maggots

SUCCESSFUL use of maggots in healing wounds has led to the synthesis of the compound produced by the larvae responsible for their effectiveness. Known as Allantoin, this synthetic glyoxyl diureide is compounded into a variety of preparations convenient for use in healing wounds of various kinds and in various parts of the body. The effect of this material is to cause granulation of the tissue.—*D. H. K.*

Super Special on Wheels

THERE are at least 57 varieties of unusual innovations in the remarkable new super-automobile that has just been designed and built by Rust Heinz, young scion of the Pittsburgh House of Heinz. Although

WAGES

MORE than half the motorists in the United States earn less than $30 a week.

only 23 years old, he has evolved one of the most striking motor-cars ever conceived, which he calls the "Phantom Corsair." It is distinguished by its unusual provisions for safety and comfort at high speeds.

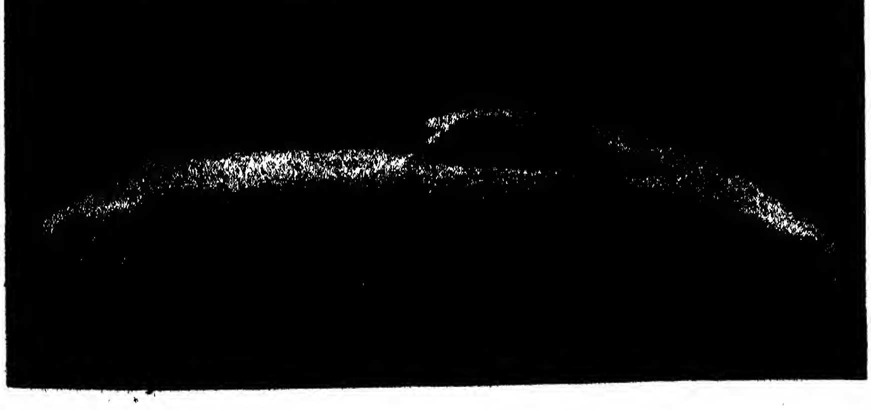
Four passengers ride abreast in the front seat and two more in the interior rumble seat. The interior is lined throughout with slab rubber in all places where injury might occur to occupants in an accident.

The car is built with front-wheel drive, electric gear shift, four forward speeds, and develops a speed of 122 miles per hour with a small engine. The wheels are independently sprung and mounted on General-made, multi-vaned, Dual-10 tires, whose squeegee action under braking conditions provides maximum traction. The hydraulic double-action set-type shock absorbers are adjustable at the dash and thermostatically-controlled air conditioning provides either heat or cold.

The "Phantom Corsair" has neither fenders nor running boards. The seats are molded of cast rubber, without springs, and the ceiling and interior side-walls are lined with cork composition three-quarters of an inch thick. There is a layer of sponge rubber under all upholstery, while the steel crash-board has a two-inch thick rubber covering; everything is sound-proofed and shock-proofed.

All of the glass is bullet-proof for safety, is tinted green to prevent glare, and is slanted inward toward the top to eliminate reflections. The hidden all-wave radio has two speakers and the roof doors open simultaneously and automatically with the regular doors.

Young Heinz, educated at Andover and Yale, followed naval architecture in New York until he designed and developed the "Phantom Corsafr" on the West Coast. Preliminary models were studied in a wind-tunnel of his own design. He is now busy in Pasadena on several other unusual cars that he has been commissioned to build.



Below: **Ultra-modern in design and conception is the "Phantom Corsair."** *Above:* **A close-up of the front end, showing the louvres and headlights**

A New Insecticide

IN the effort to find insecticides which leave no poisonous residue on the crops they protect, many new chemical compounds have been studied. One of the most recent of these is nicotine thiocyanate. This compound, prepared from the nicotine by-product of the tobacco industry by reaction with ammonium thiocyanate, is definitely more stable in use than other nicotine compounds. Tests with red spiders and with aphids have shown it to be effective particularly if a wetting agent is included in the spray. One of its important advantages is that it does not affect foliage nor does it leave a toxic residue.—*D. H. K.*

Electricity and Human Welfare

THOSE engaged in the electric utility business have long felt that electricity has been the greatest single factor in promoting prosperity in this country in recent decades. Figures recently released by the National Industrial Conference Board portray this relationship in a striking way.

They show that for the three decades ending with 1929, the industrial production of the nation increased 210 percent. During this same period, the power used in industry increased 331 percent. What this much greater use of power has meant to the people of the country is indicated by the figures showing that while during this 30-year period the level of wholesale prices gained 80 percent, the hourly earnings of industrial workers increased by 260 percent, and their real wages, measured by what their wages buy, increased 100 percent.

Some further figures recently published by the Conference Board show how effective the utilities have been in recent years in pro-

ducing economies. Since the low point of the depression in 1933 and up to June, 1937, the cost of living has advanced 18.7 percent. In this total, the item of food has increased 30.1 percent and housing is higher by 35.7 percent. In contrast, the cost of fuel and light has actually decreased 1.8 percent.

Departing now from the Conference Board figures and using those of the Edison Electric Institute, we find that the average rate per kilowatt hour for residence electricity has gone down over 18 percent during the same four-year period, and that this impressive showing has been made in spite of the fact that the proportion of gross earnings paid out in taxes by the electric utilities has risen 16 percent.—CHARLES W. KELLOGG, in Stone & Webster *Bulletin*.

Heart Affliction Seen as Cause of One Kind of Insanity

THE old time novelists frequently saw a broken heart as a cause for insanity. Today a modern scientist traces one form of insanity to a physical heart affliction, *Science Service* reports.

Investigations which seem to link the widespread mental disease known as dementia precox with rheumatic heart disease were recently described before the American Association for the Advancement of Science by Dr. Walter L. Bruetsch of the Indiana University School of Medicine and the Central State Hospital at Indianapolis. The hearts and brains of eight out of every 100 dementia precox victims that Dr. Bruetsch was able to examine after death showed signs of a chronic rheumatic infection, he reported.

The findings suggest, Dr. Bruetsch said, that the large group of mental disorders which today go by the name of dementia precox will in future turn out to be a number of different diseases with different causes.

Dr. Bruetsch's findings also suggest that the old time novelist who ascribed mental disease to emotional upsets was pretty far off in his diagnosis. Even modern psychiatrists who hold that mental disease is always the result of emotional or environmental stress are wrong, in Dr. Bruetsch's opinion. Changes in the brain tissue, such as the rheumatic condition he found, he indicated, may be responsible for mental disease, rather than disturbances in the mental activity of the brain.

Eliminating Bovine "Milk-itosis"

THE bovine female is a ruminant without ability to ruminate (in the mental sense). Cow carelessness is nowhere so much in evidence as in the complete disregard for consequences with which the animal packs away her food. In the spring a cow's fancy lightly turns to garlic, to wild onions. If she had happiness in her soul, as Yale's famed William Lyon Phelps contends, the cow must surely have considered the irrelevance of dining on garlic. If she had the public's welfare at heart, she'd think twice, if she could, about loading her milk with the objectionable odor of onions, odoriferous weeds, and similar tasty, if foul-smelling morsels, all of which transfer their odors to the milk.

In the past, boiling, steaming, or blowing air through the milk have been used to remove part of the odor and taste of onions and garlic. These methods, however, generally make the milk less suitable for sale than a newer method which removes all odor and taste of onions and garlic.

The answer to the dairyman's problem was uncovered by the Agricultural Experiment Station of the University of Tennessee at Knoxville. This agency worked on the problem of treating the milk so the fat in it would give up its odors. Technicians at the Station found that petroleum white oils act as odor removers when applied to milk.

The Station experimented with a number of oils and found that best results are obtained when 10 percent white oil is added to 90 percent milk and agitated rapidly in a milk can, bucket, tank, or other suitable vessel. Less than two minutes' stirring is ample. Beating or too severe agitation must be avoided as this may cause air bubbles to form and interfere with separation of oil from the milk. After the oil has been broken up into minute particles and dispersed throughout the milk, the mixture is permitted to stand undisturbed until the oil and milk separate. The oil rises to the top, carrying with it the minute particles of fat which contain the offensive odor and taste, and is then siphoned off. A comparatively small amount of butter fat is lost in this way. A faucet at the top of the container may be used to draw off the oil or one at the bottom to draw off the milk. One treatment is usually sufficient, though sometimes two may be necessary to remove all odor and taste. Exceptional cases have occurred where milk had to be treated three times.

An alternate method suggested by the Experiment Station for removal of the oil calls for the use of a creamery-type strainer with a pad of absorbent cotton or several thicknesses of cheese-cloth on the surface. When the cloth is wet with milk or water, only milk will pass through, leaving the oil in the strainer. The cloth may be removed and the oil squeezed or washed from it.

To reclaim the white oil, a soda solution is suggested which removes the odor-bearing materials absorbed by the oil. This process is followed by a series of washings in water and steaming to free the oil of other foreign matter. The oil is then sterilized and may be used over again.—*Esso Oilways*.

FIRE FIGHTER

METHYL bromide, which has the advantage of a much lower boiling point, is a far more efficient fire extinguishant than the widely used carbon tetrachloride.

Dull Varnishes and Enamels

DIATOMACEOUS earth, composed of nearly pure silica, the remains of microscopic animals, is now used after special treatment to produce a dull finish in paints and varnishes. The minute particles of silica produce a microscopic roughening of the surface which gives it a smooth, velvety finish. The advantage of the new

flatting agent is that it does not reduce the life of the film as do waxes and other flatting agents previously used. The surface can be washed and cleaned in the regular way without harming the surface or destroying its finish.—*D. H. K.*

A CAR IS BUILT

CONSIDERING the time for mining coal, growing cotton, tapping rubber trees, shipping various products to and fro, and the fact that there are in the modern automobile something like 35,000 individual parts, an executive of the Chrysler Corporation says that it is ridiculous to speak of one car being built every few hours or few days. The man-hours would be impossible to calculate with any degree of accuracy but would run to a sizeable figure.

Electric Furnace Elements

IN a brief article in our January issue regarding a new electric furnace element, the statement was made that "the elements now in use in electric furnaces cannot reach higher temperatures than about 2400 degrees, Fahrenheit. . . ." This statement should have been modified as we later learned from Mr. W. S. Evans, of the Globar Division of the Carborundum Company. He writes us, in part, as follows:

"The Globar electric heating element, which has been manufactured since 1923, can attain temperatures up to 3000 degrees, Fahrenheit, and in some special elements a higher temperature. We have many furnaces which operate at a great deal higher furnace temperature than 2400 degrees, Fahrenheit."

Half of Average American Families Eat Third-Rate Diet

MANY an American family that would not buy second-hand furniture or wear second-hand clothes is eating a third-rate diet. This is apparent from a survey of typical food expenditures made by Dr. Hazel K. Stiebeling of the United States Bureau of Home Economics which the Bureau has published at Washington.

Size of the family pocketbook was not the only or perhaps even the chief factor responsible for the poor nutritional quality of the family's diet. At every expenditure level above 100 dollars per person per year, some families were able to provide themselves with very good diets. The reason more families do not get good diets is chiefly because they do not know how to select the most nourishing foods for the money.

As might be expected, the tables of the well-to-do families were more frequently and more liberally supplied with milk, butter, eggs, fruits, and green and leafy vegetables. These are classed by nutritionists as the "protective foods" because they protect against such serious ills as rickets, beriberi, and scurvy, and also against numerous minor degrees of ill health and undernutrition. Families spending less than 85 dollars per year per person for food, as might also be expected, obtained very poor diets.

At the median expenditure level, however, which is 130 dollars per person per year, almost one half were eating a third-rate diet and nearly another fifth a very poor diet. At this expenditure level a little over one fifth of the families had a first-rate diet.

Three fourths of the families were at the 100 dollars or more expenditure level but less than one third of them were selecting good diets.—*Science Service.*

Increasing Friction

WITH the efforts of engineers directed toward reducing friction in machines, a compound for increasing friction is especially interesting. This material is applied to rugs to prevent them from slipping on polished floors. It is a synthetic powder which has a high coefficient of friction yet which will not scratch or mar the floor or damage the rug. Rugs treated with it are easy to pull about but will not move when weight is applied. The powder can be readily removed with a vacuum cleaner when desired, leaving the rug uninjured. The name under which the material is sold is Rug Root.—*D. H. K.*

Meters

WIRE but three thousandths of an inch in diameter, smaller than the hair from one's head, is flattened between powerful polished rollers and made into delicate springs for light or exposure meters such as used by photographers; wire three times as small, so fine the human eye can scarcely see it, is smoothly wound into tiny coils of a definite and exact number of turns for aircraft instruments; instrument pivots are made with points sharper than the most perfect needle. All this is done in the meter and instrument laboratory and workshop of General Electric in its West Lynn plant, as part of the daily routine which turns out 4000 or more meters and small measuring instruments per day.

Meters and other measuring instruments are the yardsticks of the electrical industry. Their most common use is the accurate integration of the flow of electricity into the home, but they also perform many other jobs equally as important. For example, there are now instruments which measure time more accurately than the clock with the long sweeping pendulum, which analyze and measure color far better than the human eye could do, which measure sound, detect and measure vibrations, search out strains in metals, measure illumination and films of oil but one molecule thick, and do dozens of other intricate chores where minute measurements are necessary.

To assure accuracy in the operation of such delicate measuring instruments requires thousands of small jewels, such as are used in balancing the wheels in a watch. These sapphires, some scarcely bigger than the head of a pin, are cut with a cuplike depression in which sharply pointed steel pivots are supported in perfect balance and with the least possible friction. These jewels are so small they must be handled with tweezers; each is inspected for imperfections under strong microscopes.

Making the sharp, pointed instrument pivots is another intricate job. A woman, sitting before a jeweler's lathe, guides a spinning disk of white, translucent stone. Back and forth across the face of the stone she moves the whirling pivot—a tiny bit of special steel, unbelievably hard, mounted in aluminum. She examines the point with a magnifying glass. One more touch of the stone, and the pivot is sharp—sharper than the most perfect needle. It is, in fact, too sharp for a bearing. So, with a tool made from jasper, she rounds the end. The finished point is still sharper than any needle, but the end is rounded and its radius is about half the diameter of a human hair.

An operator, armed with tweezers, lifts each of the springs mentioned above, slips it on a torsion-measuring device, and measures the force it will exert. Unerringly, this device detects differences in spring torque measured, not in inches and ounces, but in much smaller units—millimeters and milligrams. By this classification a spring is chosen that exactly fulfills the engineers' specifications.

Included in this unusual workshop are four small rooms. In two, frost covers the window panes; the temperatures within are 4 and 40 degrees below zero, respectively. The other two rooms are maintained at the torrid temperature of 122 degrees above zero, Fahrenheit, and one of the two is a miniature tropical jungle dripping with moisture, for the humidity within is 100 percent. In each of these rooms a representative collection of meters and instruments proves, by withstanding unnatural conditions, that every instrument is fit to meet the severest tests that ordinary service can offer. These meters and measuring devices must also pass a severe vibration test before they leave the factory, to assure that they will stand up if used in a locomotive cab, on an airplane dashboard, or in some industrial plant where there may be excessive vibration. In other words, these instruments are delicate in the sense that they can measure the smallest quantities, but rugged in the sense that they can withstand almost any condition to which they may be subjected.

Motor Reversed on Fiat "500"

ONE of the ingenious methods by means of which a large amount of passenger space is secured in the little Fiat "500," which is called a miniature big car, is the fact that the engine is actually turned end-for-end as compared with the usual method of mounting. The radiator is at the rear of the engine and rests just above the bell housing or clutch cover. Not only has a great deal of space been saved in this manner but visibility is increased at the front end of the car because it is possible to slope the hood down over the engine and out of the line of vision of the driver.

Another interesting feature secured in this actual reversal in position of the engine is the fact that the hood can be hinged at the front lower end so that it can be swung down out of the way, forward from the top, exposing the entire engine to view.

This re-arrangement of the design of the interior of the Fiat "500" coupé brings the passengers squarely between the wheels. The passenger seats are almost at the exact center of the wheelbase which is, of course, a factor in easy riding. The drive from the transmission, which is mounted well forward of the dash, is conventional, but since the transmission is out of the way of the passenger compartment there is no hump or tunnel in the floor.

In connection with turning the engine end-for-end, the entire power plant is moved up ahead of the front axle with the rear end of the engine and the radiator being located approximately at the center of the front wheels. This entirely new arrangement of the power plant, as well as of the steering gear, transmission, and other drive units, permits the car to take care of the space needs of two six-footers without any trouble while, at the same time, the compartment behind the front seat affords an unusually great amount of baggage space.

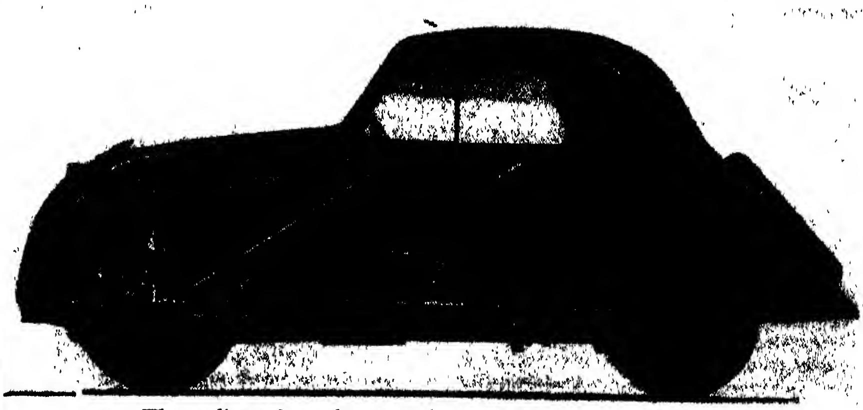
GENERATORS

EIGHT of the world's largest generators are located in the power house at Boulder Dam. Each of these huge machines contains between 27 and 28 tons of copper and its alloys.

Three-Year Study of Fever Therapy

THE School of Medicine of the University of Pittsburgh announced recently the appropriation of 50,000 dollars by the Westinghouse Electric & Manufacturing Company to launch and support a three-year program of research in fever therapy.

The Westinghouse contribution was made to aid research which may have widespread beneficial effects on the health of persons



The radiator is at the rear of the engine in the Fiat "500"

Latest fever therapy equipment for treatment of a variety of ailments

employed in industry as well as the general public. The company will not participate in the research beyond making the contribution that supports it. By agreement, the results will be made available to all medical authorities for use in improving the public health.

One of the newer fields of medical research, fever therapy has as its objective the artificial duplication of a natural process in the treatment of disease. Developing high body temperatures is one of nature's methods of killing germs. In using fever therapy, physicians induce "artificial fever" in patients as a treatment for a variety of ailments.

The full extent of usefulness of this method is at present unknown. Fever therapy has been used in treating syphilis and other venereal diseases, in the treatment of rheumatism and some forms of arthritis. The research at the University of Pittsburgh will include studies in the use of this method not only in these diseases but also as a possible method of treating a variety of other ailments including the common cold, influenza, rheumatic fever, St. Vitus dance, some forms of heart diseases, tuberculosis, and certain brain disorders, such as encephalitis.

The study will provide data on humidity and temperature as it affects the human body. This will be of great importance to industrial workers and others subjected at times to unusual conditions. It will also guide air-conditioning engineers in producing "artificial climate" suited to the needs of the public.

Of Small Packages

NEW containers are meeting special requirements in modern marketing and not the least interesting is the single-use type of package, which is being developed for a number of purposes.

Beer cans made a spectacular entrée into the container field, once a satisfactory lacquer was found to keep the liquid from the metal. Paper, pulp, and transparent film containers for liquids have had less spectacular success, but certain types seem to be making reasonable progress. One large oil company is experimenting with an automobile oil container which gives the customer a view of the oil, is non-refillable, and can be burned up when empty.

For similar reasons, special single-use dispensers have been developed for several proprietary articles. In this way, the serious problem of substitution of cheaper, non-advertised products is met effectively. A well-known hair tonic sold largely to the barber trade is now put in a tin tube which is destroyed as a container with the first use of the contents.

Twenty-five million single-use tubes for as many cups of coffee were made during 1937 for a well-known brand of soluble coffee. One of the principal advantages of the utilization of single-use containers for coffee is the prevention of flavor loss on exposure to air once the container is opened. Such air- and moisture-tight single-use containers may be adapted for other food products now sold in larger bulk, wherever the quality improvement would be economically justified.

A manufacturer of paints has found an application for single-use tubes which may be the start of an interesting new development. He sells uncolored or white paint in the standard sizes and supplies his dealers with tubes of colored pigments in oil. Thus the dealer needs to stock only a seventh the usual inventory, and, by maintaining a large number of colors in the tubes, can meet a wide variety of customer demand.

Single-use containers of all types, from miniature bottles to tin envelopes, are being used increasingly for dispensing powders, liquids, and pastes. One such container, a tube hermetically sealed by autogenous welding, has recently been awarded a certificate for consumer convenience in the American Management Association's Wolf Awards Competition. Such hermetically sealed containers make possible the dispensing of hair tonics, flavoring extracts,

and even alcoholic beverages, in "one-dose" quantities. The "tooth paste cocktail" is on the way. The number of applications for single-use containers is daily increasing, and special packing equipment is being developed for even wider application.—*Industrial Bulletin* of Arthur D. Little, Inc.

SAP PRESSURE

TOMATO roots grown as orphans—without plant bodies—have developed under test a pressure powerful enough to send sap as high as California big trees, or about 100 pounds per square inch.

U-V-Ray Hand Lamp

ULTRA-VIOLET light, which has many uses in industry in the examination and careful inspection of materials and in crime detection and legal work, may now be produced by a small and easily portable instrument. The new lamp, called the Eveready Fluoray, is a carbon arc lamp suitable for field and laboratory work wherever 115-volt current, either alternating or direct, is available. The arc is entirely enclosed and ultraviolet rays are emitted through a removable filter of special glass which transmits ultra violet yet screens out all but a trace of the visible light from the arc. Several other filters are available for light of various wavelengths. In addition to being a very powerful source of ultra violet, the essentially continuous spectrum of the carbon arc assures the presence in the light source of all wavelengths to which fluorescent materials respond.

The lamp is made into a simple hand instrument as shown in the accompanying illustrations and is a sturdy, light-weight unit, weighing approximately 2½ pounds. Operation of the lamp is said to be simple and inexpensive.

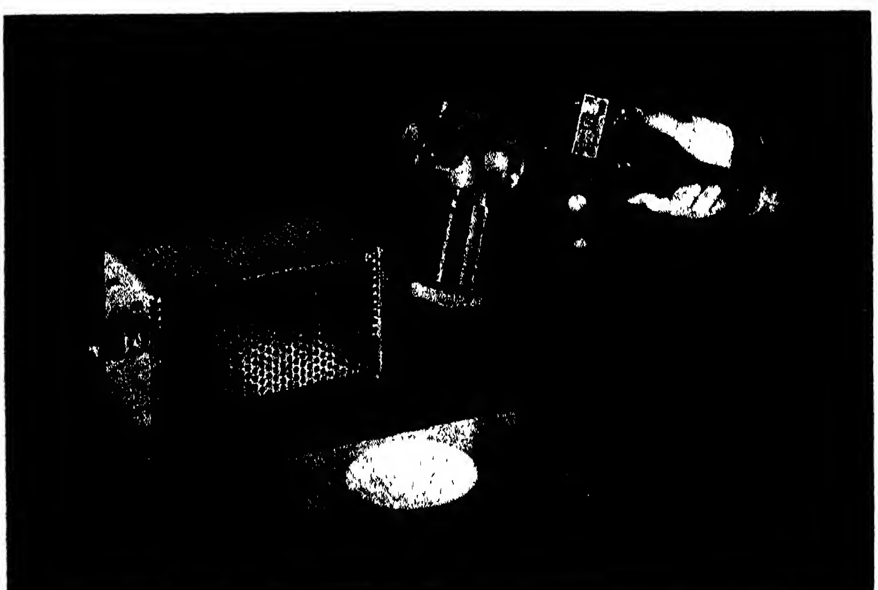
This new lamp is of particular value in producing fluorescent effects in the examination of such materials as minerals, chemicals, oils, drugs, organic substances, and food products, where fluorescence is a determining characteristic of the material itself or where, by means of fluorescence, adulterants, lack of uniformity, or non-identity of specimens can be detected. It is also admirably adapted to the examination of documents for evidence of alteration, forgery or fraud, disclosing chemical erasures, differences in ink, and peculiarities of paper. It is used to detect invisible writing and for many other purposes in the field of crime detection.

Silent Wall Switch

THE snap of a switch, indicative of progress and the adoption of modern methods, has finally been superseded as the symbol of electric control. After several years of development, General Electric's construction material division at Bridgeport has placed in production a new switch in which the contact is silently made and silently broken by the movement of mercury.

More important to eventual users than the silent operation is the fact that the new switch, small and compact, has literally nothing to wear out. There is no spring that can be broken and no blades to hammer them-

Above: Portable lamp for U-V ray production. *Below:* The lamp in use examining a document for erasures



Right: **The few and simple parts of the new silent wall switch in which the contact is made by mercury. The new switch *(below)* is much smaller than the conventional wall switch**

selves away. Actual switching elements have operated more than 65 million times in two years in a laboratory life test without failure. Some indication of the possible applications of the new switch in a single field is given by the fact that approximately 15 million house switches are purchased in the United States every year.

The actual switching element in the new device is the size of a small coat button, composed of two metal disks sealed with glass, completely enclosing the mercury make-and-break of the switch which consists of a tiny globule of mercury which completes the circuit between two contact points when the switch element is rotated by the conventional lever. The switch can be installed in any standard switch box, and must be mounted vertically.

Salt Dries Turpentine

TURPENTINE which has been dried by passing it through a thick layer of rock salt can be successfully packed in iron drums. Turpentine made in the ordinary way without dehydrating is discolored by the corrosion of iron and hence has always been packed in wooden barrels. By using this new process for removing traces of moisture an economy can be effected in shipping turpentine in iron drums, which are returned after use.—*D. H. K.*

For a Future Generation

A SCIENTIFIC experiment which will take 200 years to complete is being attempted at the University of Notre Dame.

Six cultures of bacteria, sealed in glass test tubes, have been deposited in the cornerstone of the new biology building to remain there until the building is torn down. According to present building statistics the structure should last at least 150 or 200 years.

The object of the experiment is to determine how long this type of microbe can exist outside of bodies. Sealed with the test tubes is a statement typed on linen paper which reads:

"These cultures are being sealed June 6, 1936. They have been taken from the culture library of the bacteriological laboratories at the University of Notre Dame. They have been examined microscopically and

have been shown to be in the spore state. They were viable when sealed.

"To the one that opens them it is suggested that they be cultured on the medium on which they have been grown. The medium is veal infusion agar. (Signed) James A. Reyniers, head of laboratories of bacteriology."

Spores are the resistant form of microbes and can withstand extremely high temperatures. They have been known to exist for years without food of any type. Stories have been reported of their being found in mummies taken from old Egyptian tombs, but these reports have never been scientifically substantiated.

Among the six cultures were the germ which causes lockjaw, another which for the most part is harmless, and one which eventually becomes food for protozoa.

Aerogels

TO produce an extreme fluffiness in relatively heavy materials, water is removed from gels, similar to jellies, leaving what might be called an air jelly. By this process the oxides of silicon, chromium, nickel, and aluminum have been made so light that they weigh only two to seven pounds per cubic foot. These products expose enormous surface areas per pound of material and are hence highly reactive chemically as catalysts. They are also excellent heat insulators. When added to materials that tend to cake, they promote freedom of flow and make granulation easy.—*D. H. K.*

A Nut to Crack

THE following communication was recently received from one of the readers of this magazine in Boone, North Carolina. Perhaps other readers who enjoy the exercise of their ingenuity and mental resourcefulness will wish to stop temporarily after reading his letter and attempt to deduce the correct answer, which is probably the one stated three paragraphs below. In advance, we offer the hint that the answer is scientific but perhaps not nearly so complex as might be anticipated, and it is not the will-o-the-wisp:

"There is an odd light down here," our inquirer states, "that appears in the woods at night. It is unlike a jack-o-lantern, since it seems larger and more transparent. While lying in my cabin one night I saw this light through the door and about 40 yards up the path. Suddenly it took a horizontal direction and after a few moments it went out. Then it came on again. A friend has informed me that on another occasion he saw a similar light and watched it for a half hour while it moved around. At times it would rise 30 feet or more in the air and come down again. A third person told me

that in Tennessee he had followed such a light and shot at it upon its near approach and that it seemed to fly all into little sparks. What is this light?"

The above description was referred to Prof. W. J. Humphreys, meteorological physicist of the United States Weather Bureau and author of a standard text and reference book entitled "Physics of the Air," which treats of many unusual atmospheric phenomena. Many peculiar phenomena have come to the notice of Dr. Humphreys, especially as other scientists, when they are stumped by such questions, often refer them to him as a final court of resort.

If one has conjectured all sorts of intricate explanations, Dr. Humphreys' reply, because of its simplicity, will perhaps entitle one to smile after reading the following:

"The curious, floating, ghostly light, now up, then down and round about, presumably was nothing other than an owl out hunting. His lantern was fox fire obtained by spending the day in a decaying hollow tree. When he came out at night the fox fire (phosphorescent fungi) was clinging to his feathers, hence the ghostly light that bobbed about as the owl himself rose and fell in his movements. This same phenomenon has been reported as ball lightning from another portion of the country."

No wonder the poor spook "flew into little sparks" when it was shot at!

SUN HEAT

THE largest solar water heater in America was built and installed by students at the Punahou School in Honolulu. The system covers 308 square feet of roof area and contains 1400 feet of copper tubing.

Fluorescent Chalk

A FLUORESCENT chalk which glows with a strong green light and is visible at a distance has been developed recently by the Westinghouse Electric and Manufacturing Company.

This new material appears and marks like ordinary chalk under normal light. It glows in the dark when irradiated with ultra-violet rays such as from a sunlamp enclosed in a black globe.

Doctors find this chalk useful for jotting down memoranda on a blackboard during the course of a fluoroscopic examination. It also provides a new tool for the lecturer who, during the showing of stereopticon or moving pictures, wishes to put a visible written message on the blackboard for his audience. This novel medium is especially valuable for use during the showing of moving pictures with sound.

Dementia Precox—New Treatment

THE medical and psychiatric worlds are watching with interest the friendly rivalry which has broken out abroad between the insulin-shock treatment and the newer metrazol (cardiazol) therapy of dementia precox, especially since both forms of treatment have been introduced into this country. The insulin treatment, introduced by

HARMONICS CHANGE IMPEDANCE

A resistance 4 and an inductive reactance i3 give a fundamental alternating current impedance of

$$4 + i3$$

The impedance for a second harmonic is:

$$4 + i3\ (X2) = 4 + i6$$

The impedance for a third harmonic is:

$$4 + i3\ (X3) = 4 + i9$$

The impedance for a current formed of the fundamental and the second harmonic is:

$$(4 + i3)\ \&\ (4 + i6) = 4 + i4.5 - j1.5$$

and the corresponding impedance for a current formed of the fundamental and the third harmonic is:

$$(4 + i3)\ \&\ (4 + i9) = 4 + i6 - j3$$

Sakel of Vienna, has already benefited a considerable number of cases previously considered hopeless. It consists essentially of the production of a series of daily shocks with gradually increasing doses of insulin. The insulin, after injection into the patient, exhausts the sugar content of the body and usually produces coma. In some cases, the patient may also have convulsions. After remaining in the coma a short time, the patient is revived by the feeding or injection of a glucose solution.

The metrazol treatment, which may be classed also as a shock treatment, was first developed by von Meduna of Budapest who calls it a convulsive therapy. The convulsions are induced by a rapid intravenous injection of metrazol.

According to von Meduna, the treatment is given twice a week for five to ten weeks. The results reported by this investigator compare favorably with those obtained with the insulin shock treatment.

The metrazol treatment is being introduced in the state hospitals for mental disease in New York State and the results thus far are encouraging. The insulin treatment has been used in most of these hospitals for several months with results similar to those obtained in other places. A considerable number of patients who had been considered hopeless have recovered and have gone back to their homes. Marked improvement has occurred in many other cases.—*Health News* (New York State Department of Health).

Gluing Copper Sheets

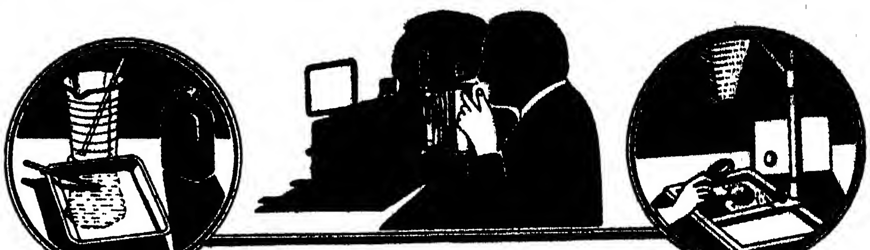
Thin sheets of copper are permanently attached to walls by a new type of adhesive, based on glue, recently developed, giving the interior decorators a new medium with which to work.—*D. H. K.*

Anatomical Shirt

The Mine Safety Appliances Company recently placed on the market a unique garment known as the Anatomical Shirt, for practical and graphic instruction in the location of arteries, bones, and organs of the torso and arms.

For first-aid instruction

Vastly superior to charts in human interest, the M.S.A. Anatomical Shirt is true-to-life and provides an unforgettable picture of the physical features constantly referred to in instruction and is essential to a working knowledge of first aid.



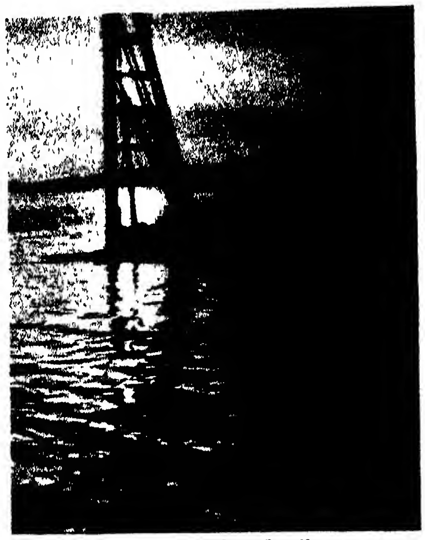
CAMERA ANGLES

Conducted by JACOB DESCHIN

The Setting Sun

SUNSETS are exasperating subjects to photograph, as any camera user knows who has attempted to reproduce in a "black-and-white" negative the wonderful beauty of a wonderfully beautiful sunset. If you are one of those who have sighed for sunsets to conquer (and of course you are), why not try the alternative of tilting your lens down to earth (or water) and photographing the effect of a setting sun rather than the source itself? You will have greater chances of success and come away with pictures that often will prove ample compensation for the effort.

Exposures will have to be made on the full side to record detail, where possible. For example, take "The Setting Sun." In order to get a proper reading for the subject, the meter was pointed not towards the area where the sun is actually shedding its beams, but towards the darker portions of the water. The silhouetted subjects are practically without detail, as silhouettes should be, but the water is properly rendered in the relative contrasts observed in the original. The position of the camera was so maneuvered as to avoid the direct rays of the sun, which is here effectively "screened" by the framework of the taller silhouette.

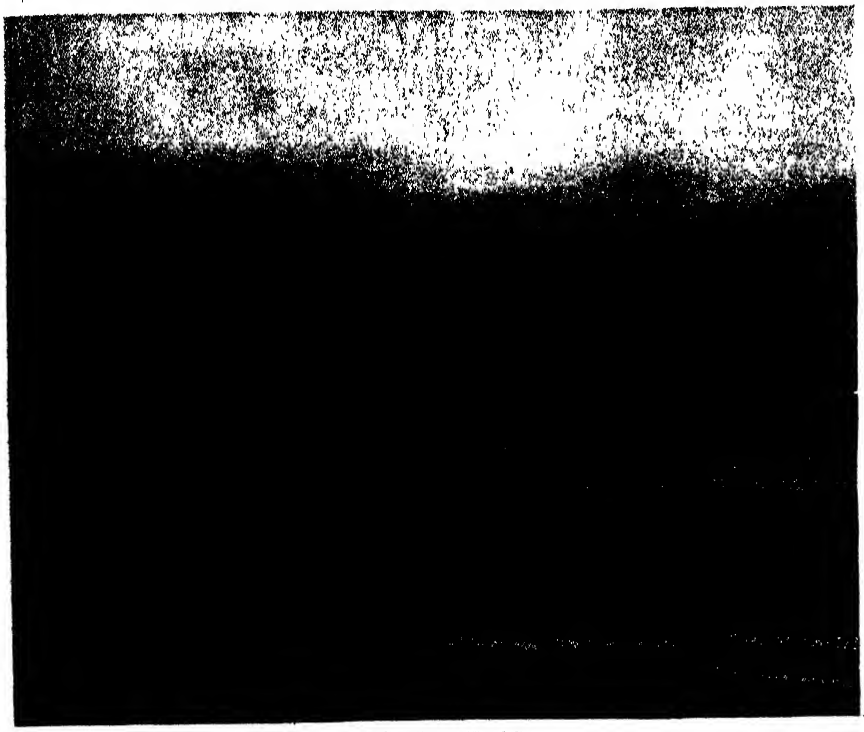


"The Setting Sun"

In "Ice Glamor" a similar effect was obtained, this time on the thin ice of a partly frozen surface of a park lake. The sun was hidden by the clouds, which may often be relied upon to help out in similar circumstances, rendering a seemingly impossible subject eminently possible and worth the patience involved in waiting for clouds of sufficient density to come along to do the job.

"The Home Trek" and "The Day Ends" interpret the human interest viewpoint and indicate some possibilities in this field that are well worth trying at any time. Taking

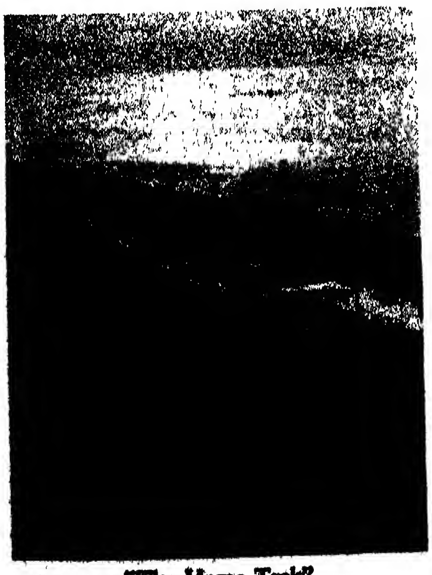
"Ice Glamor"



"The Day Ends"

several exposures of the subject, some over and, perhaps, some under that which you believe is correct, will afford you the darkroom opportunity of deciding which of the negatives best expresses what you had in mind when you pressed the button.

"The Home Trek" pictures a string of cars in each direction, all of them presumably on their way to some resting place for the night, if not actually home. The exposure of 1/50th of a second was the fastest that could be risked considering the lighting available and the necessity for stopping down a little, to F:5.6, in this case, in order to get fairly satisfactory depth of field. However, because of the distance, this speed was sufficient to "stop" the cars. Full detail, of course, was not essential because atmosphere and not representation was the effect sought. Maybe the sun splotch on the water doesn't look especially attractive, but this is just the way the water looked. In order to get some detail in the water, it was necessary to do some dodging under the enlarger, the land portion being exposed for what was considered the required time and then shaded with a cardboard to allow extra exposure of the water.



"The Home Trek"

"The Day Ends" is distinguished chiefly by the delicate contrast between the sky and water tones and the general contrast of these tones with the monotone of the rest of the picture. Happily, three figures came along to add the human touch—a man, a woman and a child—and the manner in which they are spaced helps considerably to add interest and a story-telling quality to a rather solemn subject.

Speed Films and the Meter

The recent announcement of the unprecedentedly high-speed Agfa film emulsions has created the necessity of stepping up the film speed range of contemporary exposure meters. Quick to fall in line with this newest development in modern photography is the Mini Photoscop electric exposure meter, which is now available with the "29" marking, the Photoscop speed number for Agfa Super Plenachrome Press in daylight and also used for Agfa Ultra-Speed Panchromatic film for 35mm cameras. Owners of the Mini Photoscop in which the film speed scale does not exceed "26" may arrive at the same results by a simple adjustment. All that is necessary is to set the meter at "26" and then reduce the lens opening by one stop. The alternative method is to use the "26" exposure but cut the indicated time in half. For example, if the exposure data reads F:8 at 1/50th, use stop F:11 at the same shutter speed, or keep the lens opening at F:8 and shorten the shutter speed to 1/100th of a second. A similar procedure may, of course, be followed with other meters as well.

The significance of the new high-speed films is being appreciated by users of cameras equipped with F:2.9 or F:2.8 lenses, for the new film does the remarkable service of

actually increasing the speed of the lens to F:1.5. Thus, an F:1.5 lens using "23" speed film and an F:2.9 lens using the new "29" film would give approximately equal exposure results.

Super-Sport Dolly

INCLUDING a built-in, lens-synchronized range finder of the split-image type, the Super-Sport model is announced by Burleigh Brooks, Inc., as the newest camera in the Dolly series imported and distributed by this firm. Available either with the Schneider Xenar F:2.8 lens or the Zeiss Tessar F:2.8, the Super-Sport has a self-erecting closed front, front lens focusing up to 5 feet (with lens and shutter moving together, not merely the front element alone), optical eye-level view finder, leveling piece, hyperfocal distance table on back of camera and genuine leather bellows, with the camera body finished in fine grain leather.

The Super-Sport Dolly delivers either 16 vest pocket size (1⅝ by 2¼ inch) pictures or 12 square-type (2¼ by 2¼ inch) pictures, using Number 120 roll-film. The view finder listed above is so designed that suitable masking is provided when the smaller size negative is wanted.

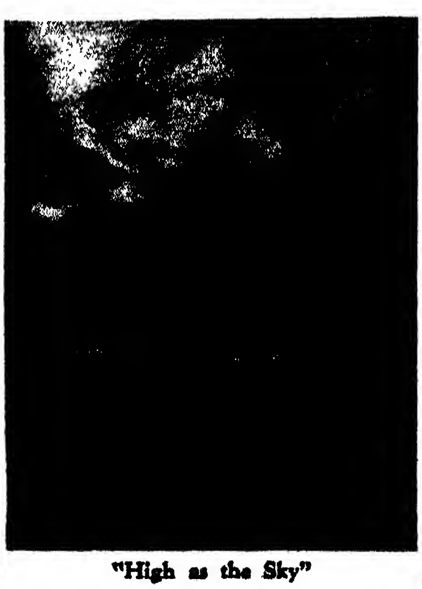
When supplied with either of the lenses, the Super-Sport Dolly may be had either with the delayed action Compur shutter, giving shutter speeds up to 1/250th of a second, or with the Rapid Compur shutter, giving speeds up to 1/400th of a second.

The camera measures 5¾ by 4⅛ by 1¹¹⁄₁₆ inches and weighs 24 ounces.

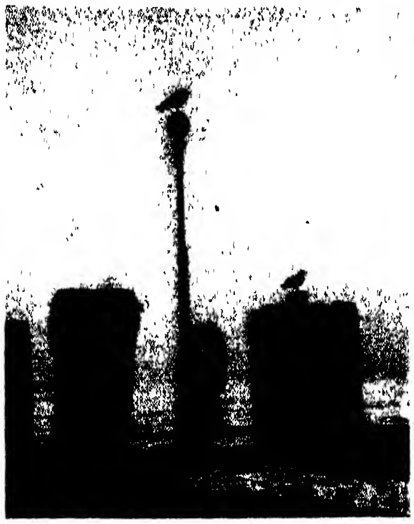
Photographing Seagulls

LIKE the pigeons and the sparrows, the seagulls are always with us, and we doubt if there is a single amateur in existence who has not at one time or another taken a shot at one or all of these subjects —if only just for luck. And luck, indeed, plays a great part in these camera adventures, particularly where seagulls are concerned. The beautiful compositions which sometimes may be caught must be watched closely, with the camera set and the finger alertly poised on the release.

One such lucky shot was "High as the Sky," here reproduced. If the engraver has done his job properly, you will see four seagulls (count them, four), graduated in perspective from the smallest (that is, farthest



"High as the Sky"



"Welcoming Committee"

away), in the lower left hand corner of the picture to the nearest, brightest, and most distinct, in the upper right hand corner. Also, if you will study the relative positions of the seagulls in the picture space, you will see that a sort of lazy curve leads from the farthest to the nearest bird, tying the whole together into a picture that looked good enough in the negative to encourage us to make an enlargement. Incidentally, the picture reproduced was enlarged from a part of a 2¼ by 2¼-inch negative and so cropped as to give the impression of wide open space naturally associated with birds.

"Welcoming Committee" is another chance shot, with the principal member of the "committee" poised atop a lamp post in one of the "strong points" of a composition and the other occupying a subordinate position. If you will cover up the wharf pilings, incidentally, you will see how necessary these latter are to the giving of strength and body to the general composition.

Monel Stirring Rod

YOU fellows who have been accidentally dropping your glass stirring rod thermometers to the tune of two or three a year, listen to this one: Announcement is made of a new-type item in this field—a combination Fahrenheit thermometer and stirring rod made of Monel metal. It is perforated on top so it may be suspended from a convenient hook or nail and has a crusher on the bottom.

Another item in this connection is a much less expensive stirring rod only, of stainless steel, with a crushing device at the bottom.

Viscose Sponge Hint

KEEPING the viscose sponge clean and moist while working at dark-room chores is one of the minor problems of the photographic hobby. Placing the sponge just anywhere until you get around to using it again for such work as swabbing off negatives and prints is not a satisfactory method by a long shot. It is obvious that any kind of grit that might adhere to the sponge while thus carelessly put down for a moment or so is bound eventually to do some damage to the delicate, though hardened, emulsion surface. One worker solves the problem by keeping the sponge in a 4- by 6-inch developing tray filled with water. Thus it is in-

stantly available, having a place of its own, and is clean and moist for whatever work is in store for it. Also, after each swabbing, it is helpful to rinse the sponge in clean water and squeeze out the excess. Incidentally, the term squeeze is used advisedly, for the viscose sponge should never be wrung.

Seeing Her In

RECENTLY this department had the more or less novel experience of meeting an ocean steamer in the company of news cameramen and reporters aboard a Coast Guard cutter. It so happened this particular ship was not specially fruitful in the way of celebrities and the nearest the cameramen could get to a picture was that of a couple of young girls who had crossed the ocean alone. However, the girls declined very decidedly, simply by running away from the cameramen and nothing would bring them within lens-shot.

One of the advantages of boarding a cutter in the early morning (7 A.M., Sunday) is that it gives one the opportunity of seeing how things look that early in the day. The tugboats swirling about the ship looked good to us, with the sun high-lighting the smokestacks and the smoke rising skyward, and penciling a light spot here and there on the body of the busy little boats. The picture we exhibit here shows a tugboat at the end of a sharp turn, creating in its path a seemingly sunken platform.

The Zeiss and Leitz Shows

THE fourth annual exhibitions held both by the Zeiss Ikon Company and E. Leitz, Inc., Contax and Leica distributors, respectively, are now touring the principal cities of the United States following their opening in New York City during January. Tremendous enthusiasm was evident during the New York sojourn of the shows; the pictures brought thousands to the galleries to witness the work done during the year by amateur, professional, and press photographers throughout the country.

The Zeiss show was distinguished by the fact that about 80 percent of the successful amateur contributors to the exhibition had never exhibited their work before. The show sponsors found their work often on a par with that of the better known professionals and veterans of salons. The following comment by the sponsors will be found significant:

"The amateur, and particularly the newcomers among the exhibitors, have a fresh point of view. They are not really influenced by any one or any school; they shoot on their own."

Untutored, uninhibited, they shoot what they like and the way they like. The amateur spirit alone influences them—let's shoot it this way; what's the odds, we're not asking anybody to buy this picture, and it's a wow.

The Zeiss show included more than 300 photographs, though a greater number could easily have been shown if space had been available. It must have been a heart-rending business for the jury of selection to pick 300 out of the total of more than 2000 pictures submitted.

Partly due to the greater space acquired for the showing of the Leica pictures, more than 700 photographs were included in the Leitz show. These were made by nearly 300 amateur, press, and professional photographers in 30 states of the union and 10 foreign countries.

Sponsors of both shows saw in the work submitted a real and decided trend toward solid, pictorial achievement, rather than pure trickery, slapstick, or merely candid photography. Augustus Wolfman, chairman of the Leica exhibition committee, said:

"The improved quality in candid photography, particularly among the amateurs, is evident not only in the composition, but in the tone, clear detail, and print caliber of the individual picture. Candid camera enthusiasts used to seek odd pictures of relatives and friends in awkward acts or circumstances. They were after the unusual. This humorous or sadistic trend has disappeared. Amateurs are recognizing that good candid camera pictures must have good composi-

"Seeing Her In"

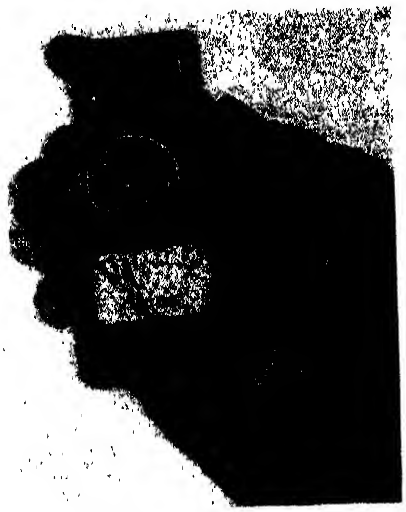
tion, accurate detail, and good print quality."

The Zeiss show committee felt the same way:

"The selections this year are more varied than last. This is perhaps due to a definite trend toward the pictorial, even in the so-called candid camera shots. That trend is now the prime characteristic of the new photography. The candid camera photographer is not content with just 'stopping the action.' He is now intent on composition as well. His success is shown by better cropping with an eye to the increased artistic values of the pictures selected for the exhibition."

Exposure Meter

Designed for use over a wide range of illumination levels, a new exposure meter has been announced by the General Electric Company. Simple in operation and sturdy in construction, the new meter is a compact, precision instrument for use in



G. E. exposure meter

taking either still or motion pictures under all sorts of conditions.

One of the outstanding features of the new instrument is the use of a hood to limit more effectively the angle of the light received to approximately that of a camera lens. The particular shape of the opening in the hood is advantageous because, when pointed at a normal scene, the full angular width of the camera lens is included in a horizontal direction, but in the vertical direction a much narrower angle is used. This lessens the error of indication caused by strong sky light. This hood, when not extended for taking readings, slips snugly over the instrument, protecting the face and light cell.

The hood, in addition to being very sharply directional, is provided with a hinged, slotted cover which when opened increases the sensitivity of the instrument by 10 to 1. In extremely low illumination, where incident light can be measured, the hood may be removed and another increase in sensitivity of approximately 10 to 1 obtained.

A direct-reading scale is provided giving *f*-values and exposure readings for the most popular films. Values for films of other speeds can be obtained by using the calculator on the hood. This calculator, consisting of a fixed plate and only one moving plate, translates foot-candles into shutter speeds for any film and lens aperture.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

AN observatory dome which observatory-dome-specialist Leo. J. Scanlon has characterized as the neatest appearing hemisphere he has seen on an amateur observatory is shown in Figure 1. Alfonson R. Ibarguen, Box 524, West Farmington, Me.,

Figure 1: **The Ibarguen Observatory**

is the maker and he states that the construction is such that the whole thing can be taken apart, since the pieces are put together with a total of about 6000 bolts and screws, all numbered. He plans later to disassemble it and ship it to his home in Guatemala. He has also made a duplicate of this observatory for Middlebury College, Middlebury, Vermont. The outside diameter is 14′ 6″ and the covering material is composition board with five coats of aluminum paint. There are 17 wooden ribs, each built of two thicknesses screwed together, and the dome rotates on eight 8″ wheels with grease cups attached. The effective shutter opening is 30″ and the shutters run on two channel iron tracks, being opened and closed by an endless rope and sheave.

The telescope is a 12½″, f/8 Pyrex-mirrored reflector and the 50-pound tube (Figure 2) is made of 20 strips of wood, 1″ x 2½″, each grooved, the whole glued together, planed, and sandpapered. Ibarguen writes: "My wife, who has worked with me from the grinding of the mirror to laying the stone terrace seen in Figure 1, and on the construction of the observatory, helped paint the tube." This attitude—correct attitude, of course, for any telescope making amateur's wife—doubtlessly accounts for the place of honor given the tube in the Ibarguen living room (Figure 2). This is the place where all amateurs should store their telescopes. In addition to this evidence of uxorial straight thinking, Ibarguen's communication states that his wife painted the inside of this tube by crawling through it, but it possibly will be inexpedient to call this little technicality to the attention of the average wife (inside diameter of tube, 14⅜″).

[Speaking of amateur telescope makers' wives, the old joke about the man whose wife gives him an urgent letter to mail and then discovers it the following spring in his overcoat pocket—unmailed—is no joke, but here is reverse English: An order for ATM has been received bearing a penciled P.S. in another handwriting which frantically asks: "Please rush! My husband gave me this to mail and I forgot it!" The letter was received 13 days after its own date-line, from a distance usually requiring only one day in transit. (To the one reader on whom light and suspicion are now dawning: no, not even if you correctly guess it will we let the lady down. See Luke 6: 42.)]

Heeding innumerable recommendations for solidity, loudly preached and prayed for by Porter, Ibarguen based his telescope on a 7′ concrete pyramid reaching 6′ below ground (deep frost line in Maine), 68″ square at base and 32″ square at top, surmounted by another concrete pyramid 14″ x 32″ which tapers to 9″ x 11″ at top. The mounting (Figure 3) is by Harry Lee Armiger, of Detroit, and is rugged and pleasing in design. Note latitude saddle.

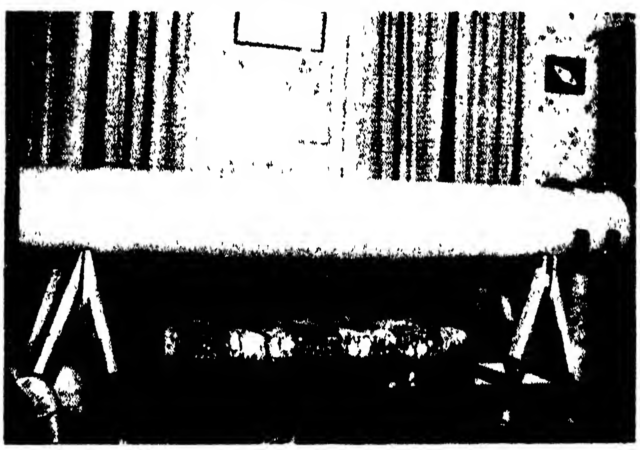


Figure 2: **Try this on your own family**

IF you admire stick-to-it-iveness, and perhaps envy it, the job shown in Figure 4 may tell you the kind of patience you will have by the time you reach about 74—the age of Mr. Elroy Gray, of North Jay, Maine. Ibarguen thus describes Mr. Gray's celestial globe: "The complete globe is the product of Mr. Gray's ingenuity. Even the wood for the stand was grown on his farm. The sphere is over 17″ in diameter and about 7000 stars are shown. The ball is constructed of successively smaller and smaller wooden rings, glued together, beginning with the largest at the equator and working toward the poles. This rough ball was then put on a lathe and made accurately spherical—and it is accurate!

"Triangles were then cut from a good grade of paper and cautiously glued to the wooden ball. This procedure is extremely difficult and guaranteed to make the most delicate of men use profanity befitting a mule driver. The various circles were beautifully drawn, and finally the stars were carefully printed. The dies used for printing these were made of common nails, filed flat on the ends and cut into various shapes and sizes, to represent stars of different magnitudes. The prevailing background of the globe is blue, the Milky Way being of a slightly different shade. Description is inadequate, for you must see the globe to appreciate fully its exquisite workmanship. The following are a few of Mr. Gray's hobbies: telescope making, including mirrors, objective lenses, flats and prisms; violin making; photography; and wood working. He made his first telescope about 50 years ago, and has made in all 18 or 20 telescopes, his latest triumph being an excellent 5″ refractor."

FOR an observatory dome, which paint is superior, aluminum or white? "To help settle the point," H. E. Dall writes from 166 Stockingstone Road, Luton, Beds., England, "I have obtained two maximum-minimum thermometers and am painting two similar boxes—each ventilated to about the same relative extent as my observatory—one white and the other aluminum. A week's readings of the temperature differences in each box exposed to the sun, etc. ought to prove helpful. The one showing the least daily difference between maximum and minimum should be best." Some time later Dall writes as follows: "The tests have taught me quite a lot about the subject of radiation and emission. The upshot is that, if an observatory is for purely solar purposes, white paint is best; but if for night work, aluminum paint is best, and by considerable margins at that." The domes on Mt. Wilson are aluminum painted.

Figure 3: **The Armiger mounting**

FOR several years many amateur telescopticians have known that a Schwarzschild reflector was being made by Professor Cogshall of Indiana University, and now the job is completed. Professor Cogshall has not been doing much shouting about this job; we suspect he was mainly busy really doing it. On another page in the present number readers will find a photograph of this telescope, in connection with Professor Russell's

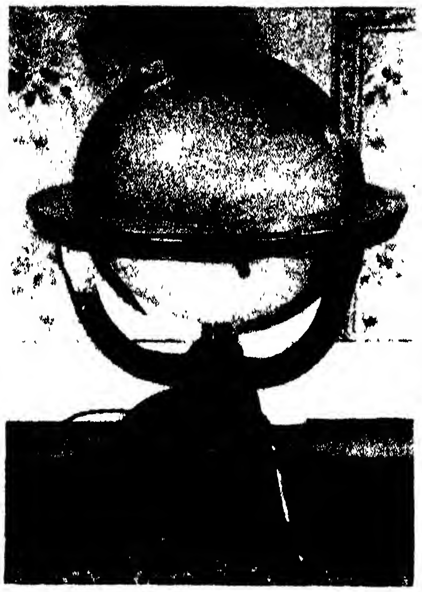


Figure 4: **Gray's celestial globe**

article. There it is characterized as "unique." This means that there is only one Schwarzschild and this is it. For years writers have written and speakers have spoken of the Schwarzschild as if it were old stuff but the plain fact is that, all this time, it has existed only on paper--Schwarzschild worked out its optics and nobody had the enterprise to go ahead and actually make one. In the photograph shown with Professor Russell's article the guiding telescope will interest amateurs: the objective is separate--no tube--and there is a diagonal opposite the declination axis which shoots the light down that hollow axis and to another diagonal belonging to an eyepiece.

Professor Cogshall, who designed this instrument, and ground and figured the mirrors, is at the guiding eyepiece.

Anticipating inquiries from amateurs who will now itch to build Schwarzschilds (and probably itch worse while doing it) we answer these here, in advance. There are no "instructions," therefore you will largely be pioneering. This will be work for the advanced amateur, and beginners are honestly and sincerely advised to pass it up till they have made a dozen or so of the common or garden variety of reflectors. By that time most of them will no longer hanker after such a job, anyway. There is a brief mention of the Schwarzschild, also a cut, on page 395, ATMA. In his series of articles (1928-1929) in the *Journal of the Royal Astronomical Society of Canada,* Ritchey mentions (p. 175, May-June, 1928) Schwarzschild's original publication of the optical design, which was in a book entitled "Theorie der Spiegeltelescop," published at Potsdam, Germany, in 1905. This work is a compound of higher mathematics and German. Just how the average amateur would now go about locating this book, except possibly in a few libraries, is something on

which your scribe has no data at this writing. No doubt the small handful of advanced amateurs who thrive on this kind of diet will dig it out, and probably Professor Cogshall will later publish an account of his work in some of the professional journals. Like the curve on the Schmidt telescope's correcting plate, the Schwarzschild's is of the fourth degree type. Harold Lower, who with his father, Charles Lower, has pioneered in fig-

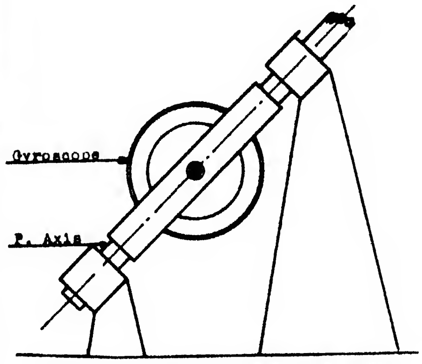


Figure 5: **The gyrotelescope idea**

uring the fourth degree curves of Schmidt correcting plates, mentions in a letter some of the odd hunches they have tried out, à la Edison (try anything once), for tools, including glass, gas pipe, buckshot, and shirt buttons. They speak calmly of making various curves and then destroying them without tears—all a part of the game and lots of fun. These curves are, of course, not parabolical but, according to the elder Lower, diabolical. The amateur—or professional—who tackles fourth degree curves should first stock up well on the old-fashioned commodities, patience, courage, stubbornness.

No doubt, after the above discouragement, everybody will want to make a Schwarzschild.

INTERESTING, at least, even if it did not turn out to be applicable, is an idea submitted by James Murphy, 621 Third Ave., N. E., Mason City, Iowa—the use of a gyroscope for stabilizing a telescope on a fixed star. His letter:

"This one is a little odd, and I can't figure out yet whether it will grow up to be an idiot or a genius. Essentially, the thing is nothing more than a gyroscope attached to the lower end of the polar axis, the idea being that the thing will keep on rotating in the same plane and drag the telescope around with it. The sketch (Figure 5) shows no method of driving it, but an electric motor would do the trick. I don't know everything there is to know about a gyroscope, but I do know that it will offer a large resistance to any force tending to change its plane of rotation. Now it stands to reason that a gyroscope isn't an immovable object. Its resistance to a given force depends upon its angular momentum. The force in this case will be applied in the form of a couple acting on the ends of the shaft, its amount depending upon the balance of the mounting and the condition of the bearings, and also upon the direction and velocity of the wind, if the thing is used in the open. If these factors were reduced to the absolute minimum, and the angular momentum of the rotor made large enough, it would seem that the amount of drift would be rather small. The problem is, could this lag be reduced to a point where it wouldn't be troublesome, without making the rotor too large? In the case of visual observation, I believe it could, but for photography, where an exposure of several hours is indicated, I don't know.

"There is also another problem. If the thing would work out all right, what about vibration? A well-balanced rotor in good bearings isn't the sort of thing which produces ground-shaking vibration, but the amount of vibration which can be tolerated in a telescope is very small. It wouldn't do to have the star images dancing around in the field of view like a hula dancer's navel. About the only way of really finding out is to try it, so if you think it worth while, you can pass it on, and see what the results will be."

The above suggestion was referred to the Sperry Gyroscope Company, Inc., which replied:

"The simplest way to describe the value of this idea is to say that the scheme is theoretically possible, but practically away beyond the technic of gyroscope engineering at the present time. There are two possible methods of attacking the job. First is the direct application of a three-degree-freedom gyro. This would necessitate a gyroscope size and weight in excess of telescope, and would make such a cumbersome apparatus that, even if it were possible to balance it accurately, it would still be impractical. To balance a gyroscope of such a size with three degrees of freedom runs into tremendous problems of reducing the bearing friction, compensating all parts for temperature change and removing all flexibility of parts so as to prevent the center of gravity from shifting with changes of compensation of the gyroscope.

"The second way would be to have a small controlled gyro and a relay system or follow-up system which, through servo motors, would drive the telescope. This can be done with sufficient accuracy for many uses where time delay or angular lag of three to five minutes of arc are allowable. In telescope work, however, where the allowable error must be considerably less than that, the technic would be too complicated, if at all possible.

"It is not a new question to us, as it has been brought up many times and our ideas as expressed here are not the result of guessing, but of our own experience in attempting to stabilize other things than telescopes."

THIS letter was sent to Murphy, who replied: "Well, I guess that's the story. It doesn't look any too promising, but maybe

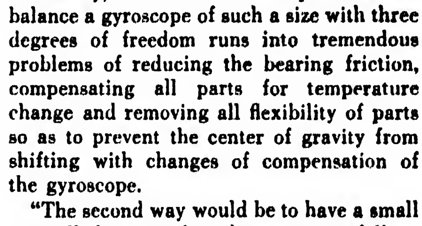


Figure 6: **Obsidian mirror—Bush**

some of the boys might surprise us all by getting it to work. If you decide to mention it in the magazine I suggest that you bear down heavily on the difficulties of making it work."

A rumor in the press has hinted that the Navy had been working on the same method, to be used for anti-aircraft firing control mechanisms, also that the big guns of the

new battleships would have gyroscopes. We don't vouch for this—it may be merely old General Rumor speaking; also a telescope is a considerably more "tetchity" critter than even a naval gun. Nevertheless, the idea is intriguing.

OBSIDIAN is a natural product commonly called volcanic glass and it resembles black glass. As a possible material

Figure 7: **Telescope class at N.Y.U.**

for telescope mirrors it is mentioned in ATM, pages 316–317. However, without being aware of that mention, Dr. W. P. Bush, American Trust Building, Berkeley, Calif., made the mirror shown in Figure 6. "A piece was sawed from the median part of a small chunk of obsidian which I found on a mountainside," he states, "the objects at either side of the mirror in the photograph being the two slabs sawed off. A toothless copper blade in a hacksaw frame was used with Carbo to saw out the desired piece, which was then made circular by means of Carbo and a tube rotated in a drill-press. Grinding and polishing were done in the usual way. The mirror is an $f/10$, and when silvered it became very good."

Often your scribe has sawed 1" by 18" (cross-section) slabs of stone, using Carbo, water, and the back of a 48" saw. Time, 45 minutes, less or more.

FOR some time the Pennsylvania State University (State College, Pa.) has been giving a course in telescope making, and now New York University (20 Washington Sq., N., New York, N. Y.) has followed suit. Figure 7 shows the classroom, which is not on the campus but in the deep basement of the Hayden Planetarium at the American Museum of Natural History. Ramiro Quesada, a member of the Planetarium staff and the instructor, is an old hand at mirror making. "This course consists of 24 lessons, three hours each, extending over a period of 24 weeks, during which time the student will not only have the opportunity to learn the technic of telescope making but will be expected to complete a telescope mirror. . . ." This official statement is quoted in order to show how our home hobby shapes up when it becomes a regular course at a university: 72 hours to make a mirror. Well, if you counted all the necessary make-ready, probably your first mirror took about that long —less or more!

NEW clubs of telescope makers, amateur astronomers, or both: Alabama Astronomical Association, B. L. Harrell, 105 N. 10 St., Gadsden, Ala., president. Amateur Telescope Maker's Club, Lorimer Knoll, secretary, 1807 Johnson St., N. E., Minneapolis, Minn. National Capital Amateur Astronomer's Association, Inc., Stephen Nagy, president, 104 C St., N. E., Washington, D. C.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

LIFE, LIBERTY, AND THE PURSUIT OF HAPPINESS tells in pictures and text how the modern machine age has given man many things that would otherwise be unattainable. It particularly emphasizes the fact that machinery does not enslave man—it emancipates him. The booklet covers briefly the whole scope of human activities, from improved homes and automobiles through various businesses and industries. *The National Machine Tool Builder's Association, 10525 Carnegie Avenue, Cleveland, Ohio.—Gratis.*

TRANE WEATHER MAGIC is an 8-page illustrated pamphlet that deals with various phases of air conditioning, particularly those concerned with theaters, hotels, and other public buildings. *Write for Bulletin 338A, Scientific American, 24 West 40th Street, New York City.—3 cents.*

PRACTICAL SPEEDS OF FILMS AND PLATES is a vest-pocket size booklet that compares speed ratings and gives the practical speed values of all the various negative types available on the American market. It is furnished in a protective celluloid envelope. *Willoughbys, 110 West 32 Street, New York City.—10 cents.*

HIGH STRENGTH CORROSION-RESISTING RIVETS FOR MARINE CONSTRUCTION is a specialized technical pamphlet dealing with the subject of its title and giving in tabular form the physical properties of special alloy rivets. *Write for Bulletin 338B, Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE OBSERVER'S HANDBOOK FOR 1938 is an 80-page annual containing numerous tables, lists and maps for amateur astronomers—lists of double and variable stars, star distances, clusters and nebulae, also an ephemeris of the sun, and, especially, data on each planet for each month of 1938. Every amateur should obtain this book annually. *Royal Astronomical Society of Canada, 198 College St., Toronto, Ontario, Canada.—Postpaid 25 cents (20 cents each if ten or more are purchased).*

NICKEL ALLOY STEELS IN OIL WELL TOOLS, by George W. Whitney, tells of the many advantages to oil-well operators which may be had by the use of alloy steels in different parts of their equipment. *Write for Bulletin 338C, Scientific American, 24 West 40th Street, New York City.—3 cents.*

GEM STONES is a U. S. Bureau of Mines pamphlet summarizing the state of the gem industry, imports, market and so on, for 1936. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

HOW TO CHANGE OVER TO WELDED DESIGN FOR PROFITS is a new 32-page bulletin, profusely illustrated, intended as an aid in applying electric welding to the design of machines and machinery structures. Of particular interest are illustrations of products as they were formerly built by some other method and of their modern arc-welded counterparts. *Write for Bulletin 338D, Scientific American, 24 West 40th Street, New York City.—3 cents.*

WHAT AN INVESTOR SHOULD KNOW is a pocket-size booklet containing 32 pages which covers briefly elementary points which are not often understood by inexperienced investors. It further describes the methods which swindlers have frequently used to defraud unsuspecting investors. The keynote of the discussion is: "Before you invest—investigate." *National Better Business Bureau, Inc., 405 Lexington Avenue, New York City.—8 cents.*

HIGH-SPEED VULCANIZATION OF RUBBER, by A. R. Kemp and J. H. Ingmanson, is a technical bulletin describing the factors involved in the continuous vulcanizing process now employed by the rubber-covered-wire industry. Monograph B-1019, *Bell Telephone Laboratories, 463 West Street, New York City. Limited free distribution.*

ANTHRACITE INDUSTRIES MANUAL OF ANTHRACITE AS A DOMESTIC FUEL is a 115-page book which presents in compact form much of the experience and knowledge which has been gleaned by a number of well-known combustion engineers. It covers a description of anthracite and its proper combustion, heating systems and equipment, and methods which should be used for obtaining a maximum of satisfaction from anthracite. *Anthracite Industries Laboratory, Primos, Del. Co., Pennsylvania.—50 cents.*

WHY AIR WRECKS? is a discussion of the causes of airplane accidents and corrective measures which have been advanced by various authorities. It includes a summary of crashes of scheduled airplane flights in the United States from August 7, 1934 to March 25, 1937 inclusive. The Commonwealth—Part II, November 6, 1937. *The Commonwealth Club of California, Hotel St. Francis, San Francisco, California.—35 cents.*

FIRES ON FARMS, Leaflet No. 44, United States Department of Agriculture, deals with the various causes of farm fires and how fire hazards may be and should be removed. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS is a handbook for safety engineers, safety committee-men, industrial physicians and nurses, and for those responsible for any industrial operations. The volume contains 247 pages and includes 59 illustrations dealing with the safeguarding of eyesight in factories, mines, shops, and offices. This handbook formerly sold for $1.50. As long as the supply lasts it is available at the special price mentioned. *The National Society for the Prevention of Blindness, 50 West 50th Street, New York City.—50 cents.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Corporation Licenses

At the present time there is pending before Congress a Bill which has received surprisingly little publicity in view of its far-reaching effect upon American business. The Bill is being sponsored by two senators of more than ordinary ability in parliamentary tactics, and accordingly, it deserves careful watching.

The purpose of the Bill is to accomplish certain social reforms which have heretofore been regarded as outside the province of the Federal Government, by requiring corporations engaged in interstate commerce to be licensed by the Federal Trade Commission. The Federal Trade Commission is given extraordinary powers to grant, modify, or revoke such licenses. Thus, the Bill provides that: "It shall be unlawful for any corporation to engage directly or indirectly in commerce without first having obtained a license therefor from the Commission." The Bill also provides "that such license shall contain such terms and conditions as the Commission shall prescribe as necessary and appropriate to carry out the purposes of this Act, shall be effective from the date specified therein, and shall continue in effect until suspended or revoked."

In order to receive a license from the Federal Trade Commission a corporation must submit detailed information as to its financial structure and must certify to the Commission that it intends to comply with the provisions of the Bill and any requirements that may be imposed by Congress as a condition to its right to engage in commerce. In addition to this the licensee must comply with certain labor and fair trade practices. Thus, no person under 16 years of age may be employed by the licensee; female employees must be paid at the same rates of pay as male employees doing similar work; and the right of employees to self-organization and to join labor unions must be guaranteed.

The Bill also contains provisions intended to protect investors. Thus, a licensee is required to have the principal place of business and executive offices in the state of incorporation. The right of a corporation to hold stocks of other corporations is greatly restricted, and the right to vote the shares of stock of a subsidiary corporation is vested in the stockholders of the parent corporation rather than in the parent corporation itself. Also, rather rigid restrictions are placed upon the financial set-up of licensees. One of the most important of these restrictions provides that the surplus of a corporation shall not exceed 50 percent of the value of its capital stock.

One provision of the Bill would introduce an entirely new element into the relations between business and government. Under this provision a stockholder of a corporation can deliver a proxy to vote his shares of stock only to a person who has been certified by the Federal Trade Commission and the Civil Service Commission as a duly accredited corporation representative. The compensation of the corporation representatives is fixed by the Federal Trade Commission but is paid one half by the corporation and one half by the Federal Trade Commission.

At the present writing the Bill is 31 pages long and it is difficult to summarize all of its provisions. However, in addition to the high-lights of the Bill as outlined above there are many other provisions which have a far-reaching effect upon every corporation engaged in interstate commerce.

One further provision that is worthy of note is that the Federal Trade Commission is given extraordinary powers of investigation, interrogation, and subpoena in connection with its duty of supervising and enforcing the Bill.

Caveat Vendor

The United States Supreme Court has recently held that laws are made to protect the trusting as well as the suspicious and that the Federal Trade Commission has the power to restrain misrepresentations even though they are palpably and obviously false and would not deceive a cautious person.

The publishers of an encyclopedia had represented to customers that they were distributing the encyclopedias as gifts and that the customer only had to pay $69.50 for a loose-leaf supplement or extension service. The Federal Trade Commission found that these representations were false; that the encyclopedias were not given away; and that as a matter of fact the publisher was selling the encyclopedia and the supplement for the price of $69.50. The Commission accordingly ordered the publishers to cease and desist from making false representations of this character. The order of the Federal Trade Commission was subsequently reviewed by one of the circuit courts of appeal and the court overruled the Commission on the rather interesting theory that the representation that the encyclopedia was given away was so obviously false that no one would be misled by it. The case was then taken to the United States Supreme Court, which overruled the circuit court of appeals and sustained the Commission on the theory that the laws are intended to protect the trusting as well as the suspicious. In this connection the Court stated:

"The fact that a false statement may be obviously false to those who are trained and experienced does not change its character, nor take away its power to deceive others less experienced. * * * Laws are made to protect the trusting as well as the suspicious. The best element of business has long since decided that honesty should govern competitive enterprise, and that the rule of *caveat emptor* should not be relied upon to reward fraud and deception."

Private Fight

The owners of the exclusive right to broadcast over the radio a description of a prize fight can restrain a competitor from interfering with that right and from appropriating news of the fight from the exclusive broadcast and furnishing it to other broadcasting stations.

The promoters of the fight between Joe Louis and Tommy Farr gave the exclusive broadcasting rights to the fight to one of the large broadcasting companies. A news agency engaged in the business of supplying news to broadcasting stations announced that it would supply its customers with a running account of the fight while it was in progress. The promoters of the fight and the owners of the exclusive broadcasting rights brought suit against the news agency to restrain it from interfering with its exclusive broadcasting rights. The court found that the purchasers of tickets to the fight were bound by agreement not to take motion pictures and not to broadcast the fight. The news agency advised the court that it intended to "obtain tips from the ringside broadcast as to the facts of the progress of the fight, and to authenticate them by independent investigation by newsgathering representatives of defendants located at vantage points outside of the stadium but within view of the bout." The court found, however, that the running account of the fight to be furnished by the news agency would necessarily be based to a substantial degree upon the exclusive broadcast, and that accordingly the plan of the news agency could not be utilized without an unlawful appropriation of plaintiff's broadcast. An injunction was accordingly granted.

8 O'Clock—on Land and Sea

A PROMINENT grocery company owning the well-known trademark "8 O'Clock" for coffee has been awarded an injunction restraining a competitor from using "8 Bells" to designate his coffee.

The plaintiff has used the trademark "8 O'Clock" for coffee since 1869 and the mark has been extensively advertised and is well known throughout the United States and Canada, while the defendant did not adopt the name "8 Bells" until the year 1932. The court found that "8 Bells" was deceptively similar to "8 O'Clock" and that its use by defendant constituted trademark infringement and unfair competition. In reaching this conclusion the court stated:

"We judicially notice the fact that the word 'Bells' is a nautical term for 'O'Clock' and so used eight bells after midnight means eight o'clock in the morning. * * * The use of the designation '8 Bells' by defendant constitutes unfair trade practice and infringes plaintiff's trademark of 'Eight O'Clock' and '8 O'Clock'."

Books SELECTED BY THE EDITORS

ALCOHOL, ONE MAN'S MEAT—

By Edward A. Strecker and Francis T. Chambers, Jr.

"ANOTHER man's poison" fittingly describes this volume, which is neither for nor against the use of alcoholic beverages. As a matter of fact, the authors believe that alcohol may be a source of normal enjoyment, but at the same time they know that there are psychological factors involved which are as important for the individual to know as for the medical man who may later be called upon to treat that man's alcoholism. Parts of the book are "The Psychology of Alcoholism" and "The Treatment of Alcoholism," these two being broken down into a number of chapters each. For the layman the first part is, of course, the more interesting, some of its chapters being "Alcohol, The Camouflaged Narcotic," "The Identification of the Alcoholic," "The Alcohol Saturated Personality," "Alcohol and Sex," and "The Alcoholic Breakdown."—$2.65 postpaid.—*F. D. M.*

THE CHEMISTRY OF PETROLEUM DERIVATIVES—Volume II

By Carleton Ellis

PETROLEUM serves as a raw material for an ever-growing number of valuable chemical synthetics. New industries are continually growing to importance in this field and development proceeds at a rapidly accelerating rate, as Volume II of Ellis clearly demonstrates. In 1934 the first volume, covering with remarkable thoroughness all the research up to that time on chemical derivatives of petroleum, contained some 1285 pages. So swift has been progress in the subsequent years that the second volume, designed to bring the first up to date after only three years, appeared in 1937 with a total of 1464 pages. The two volumes together form the standard work on the subject. Lest there be misunderstanding, let it be clearly stated here that neither volume deals with petroleum refining of itself but rather with the multitudes of products derived from crude oil and natural gas by chemical treatment.—$20.50 postpaid. —*D. H. K.*

UNIVERSAL PHOTO ALMANAC AND MARKET GUIDE—1938

AMATEUR photographers who feel that they should be able to make money with their cameras will find in this book many hints that will be of value. A series of articles tells what, when, and how to photograph, how to sell your photographs profitably, how to handle your equipment, what picture journalism consists of and how to make contacts with editors, and many other things that the would-be photo journalist will want to know. A pictorial section presents some of the work of this country's foremost photographers; a 34-page formulary gives in compact form most of the standard formulas. The market guide section tells who purchases what kind of photographs, approximately the price paid, and gives other pertinent data regarding hundreds of publications that are in the market for photographs. —$1.00 postpaid.—*A. P. P.*

FORTY YEARS OF AMERICAN-JAPANESE RELATIONS

By Foster Rhea Dulles

READERS who desire to be well-informed concerning the international background of our relations with Japan will find in this book a period-by-period history, beginning with our Spanish War days and tracing through in a clear sequence periods of the Open Door, the Boxers, the Russo-Japanese War, dollar diplomacy, and the European War, also the more familiar recent periods.—$3.15 postpaid.—*A. G. I.*

THE RADIO AMATEUR'S HANDBOOK—1938 Edition

EVERY year there is published a new edition of the Radio Amateur's Handbook—the present one is the fifteenth. It covers the entire story of amateur radio from its beginnings up to the present day. Then it presents elementary radio principles, fundamental circuits, vacuum tube facts, equipment design and construction, amateur radio telephony, ultra high frequency apparatus, and so on throughout the whole gamut of amateur radio. There are 446 pages (including an index) of accurate facts that will be of value to everyone interested in short wave communication. As could have been said for every previous edition, this one is "the biggest and best yet."—$1.00 postpaid.—*A. P. P.*

AMERICA'S YESTERDAY

By F. Martin Brown

NO previous book has covered so much territory as this new work, which is an account of our present knowledge of the early Indians, Pueblos, Mayas, and other middle Americans, the early Peruvians, Incas, and the Moundbuilders. In fact it is a full compendium of New World anthropology. It may err a little in one respect which, however, is equally characteristic of popular presentation of other branches of science: the popularizers are often more certain that the scientists are correct than are the scientists themselves. This, however, is a minor matter in connection with so valuable a survey as the present one.—$3.65 postpaid.—*A. G. I.*

PHOTOGRAPHY OF THE NUDE

By Marcel Natkin, D.Sc.

ESTHETIC photography is the essence of the present book. The author first discusses the nude in classical paintings and sculpture and then presents 32 plates showing various treatments of the nude from expressive through phantasmagoria and stylized to realistic treatment. The book is supplemented by a series of notes on technique and by a discussion of soft-focus photography and its application to the main subject. This is in every respect a serious treatment of a legitimate phase of the art of photography.—$2.65 postpaid. —*A. P. P.*

GOVERNMENT OWNERSHIP AND OPERATION OF RAILWAYS FOR THE UNITED STATES

By Lewis C. Sorrell

THERE are many arguments pro and con on the question of whether railways of this country should be under government ownership and operation. Professor Sorrell, who has been professional advisor to the Transportation Conference and to the Railway Business Association, gives us in this volume the essence of all these arguments. He shows that we have had very little experience in such operation and, on the basis of this fact, outlines the problem from the standpoint of public interest. One chapter is devoted to the subject of whether government ownership is at present imminent. A short but rather complete bibliography concludes the volume.—$3.20 postpaid.—*F. D. M.*

RAILWAYS OF THIRTY NATIONS

By P. Harvey Middleton

AS a companion piece to the volume mentioned immediately above, this

study gives the background and present status of the railway systems of the more important countries of the world. In this study must of necessity be included a considerable amount of discussion of the historical aspects and the sociological and economic factors which differ greatly from nation to nation. There are few statistics as such, though the text itself contains many figures relating to mileages, construction costs, and the like. A four-page bibliography is included.—$3.20 postpaid.—*F. D. M.*

THE BOOK OF WILD PETS

By Clifford B. Moore

A DISCUSSION on the care and feeding of our native wildlife in captivity, with notes on their identification and life habits. The author is biologist in charge of the Trailside Museum at Springfield, Massachusetts, and he appears to have a large fund of *practical*, not merely general, advice in building and maintaining quarters for a wide variety of aquatic life, insects and pet spiders, also mammals and birds, as well as in their care and feeding. This large illustrated volume is a reference book. —$5.20 postpaid.—*A. G. I.*

THE STORY OF GEMS

By Herbert P. Whitlock

A POPULAR handbook on precious and semi-precious stones—diamonds, opals, quartz gems, ornamental stones—the antique use of gems, the lapidary art, the forms in which gems are cut, and other general gem lore.—$3.65 postpaid.—*A. G. I.*

WILD ANIMAL WORLD

By Raymond L. Ditmars and William Bridges

SUPPOSE you could sit down 18 times with the men who conduct the big Zoo in New York and listen each time for an hour while they related their choicest tales of exciting happenings among the many animals that have been kept there. Doctoring under difficulties, animal myths and superstitions, the unexpected always happens, a pea-green lion, midnight in the zoo, adventures with elephants, a nose for zoo news—these are some of the subjects of the 18 informal narratives in this most readable book.—$3.15 postpaid.—*A. G. I.*

SOCIALIZED MEDICINE IN THE SOVIET UNION

By Henry E. Sigerist, M. D.

AFTER long sojourns in Russia studying his subject at first hand, the professor of the history of medicine at Johns Hopkins University describes in detail his findings concerning socialized medicine—he likes it. His account will make interesting reading to the minority who also like the same idea.—$3.65 postpaid.—*A. G. I.*

INTRODUCING THE CONSTELLATIONS

By Robert H. Baker, Professor of Astronomy, University of Ill.

A VERY elementary book full of running comment on the constellations and the important stellar features in them, organized by seasons. Attractively illustrated with numerous blue half-tones of celestial features, also with simple charts of the constellations. This is a book for relatively non-serious students of the stars, readers who do not care to dip very deep, but wish to be entertained and lightly instructed while learning the constellations.—$2.65 postpaid.—*A. G. I.*

THESE AMAZING ELECTRONS

By Raymond F. Yates

A POPULAR treatise dealing with the applications of electronics to medicine, surgery, music, television. The author gives us pictures of practical applications rather than the pure physics of the electron—though the latter is sufficiently explained wherever needed. A well-illustrated, well-rounded book which tells its story clearly but without frills or fanfare.—$3.90 postpaid.—*A. G. I.*

ANIMAL TREASURE

By Ivan T. Sanderson, B.A., F.L.S., F.Z.C., F.R.G.S.

THE entertaining, rather racy account of a young self-taught English zoologist (later with a degree from Cambridge) who, without the orthodox ideas of the professional zoologist, went to West Africa to study the behavior of animals in their natural environment instead of in cages. As science it has been scathingly dealt with in public by a Harvard zoologist on the grounds that its many errors prove the author to be over-imaginative and not a true scientist.—$3.20 postpaid.—*A. G. I.*

AUTOMATIC FREQUENCY CONTROL SYSTEMS

By John F. Rider

THE addition of automatic frequency control to the superheterodyne circuit not only permits the receiver to be tuned automatically by means of push-buttons but to be tuned more accurately than is possible by the use of a dial. The first four chapters of the book are devoted to a description of the application of basic principles; the rest of the chapters cover the different types of AFC circuits found in modern commercial receivers, their alignment, and a general discussion of their servicing. All the automatic and semi-automatic tuning systems are too numerous to be explained, but two or three, whose functioning may be considered basic and typical of many others, are covered very adequately. The explanation of what happens when a tuning push-button is depressed and how the AFC circuit compensates for the mechanical inaccuracies of automatic tuning is excellent, as is also the author's treatment of both the theoretical and the practical sides of automatic frequency control.—$1.15 postpaid.—*G. C. B. R.*

PHOTOGRAPHIC HINTS AND GADGETS

By Fraprie & Jordan

WHAT advanced amateur photographer has not at some time or other yearned for some particular piece of equipment, yet could not afford to purchase it or could not acquire it at the exact time when it was needed? That many such men have gone through just this experience and have made use of their own initiative to provide the desired equipment is definitely evidenced by the content of the present book. Here is presented a vast array of data telling exactly how to make all kinds of photographic equipment from cameras to film clips, from lighting controls to enlarging easels. Space is too limited here to even attempt to list the 250 articles which tell photographers exactly how they may make many ingenious labor-saving devices to help them in their work. Out of these 250 there will be dozens that every photographer will straightway start to make. Nearly 500 illustrations.—$3.70 postpaid.—*A. P. P.*

INORGANIC CHEMISTRY

By Morgan and Burstall

IN the general focusing of attention on the spectacular achievements of organic chemistry, the coordinating pattern of inorganic chemistry and the remarkable facts being learned about the 90-odd elements have been rather neglected. In this book the latest theories developed on the one hand by studies of atomic structure and on the other from complex organic compounds of metals are reviewed in some detail. It is not a book which a layman may expect to enjoy, but one likely to prove of important value to chemists by giving them a broad view of recent developments in their science.—$6.20 postpaid. —*D. H. K.*

SCIENTIFIC AMERICAN

ADVERTISERS

March · 1938

Advertising Manager
CHARLES H STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York
ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 158, No. 3, 35 cents a copy, $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS · APRIL · 1938

"FROM Steel to Streamliner," page 210, tells the story of the construction of a stainless-steel streamlined train, fabricated through the use of the Budd "Shotweld" process. Our cover illustration shows a workman using the Shotweld machine which might be said to bear the same relationship to ordinary welding as a needle and thread bear to a modern high-speed sewing machine. With the equipment illustrated, the expert welder controls each weld perfectly, creating a structure with maximum strength and minimum weight.

SCIENTIFIC AMERICAN, April, 1938. Vol. No. 158, No. 4, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1888)

SEA SERPENT—"The schooner Coral, Captain Sherman, is now at the port. Captain Sherman reported that recently, when his vessel was in the vicinity of Cornfield Lightship, there suddenly appeared astern and not two hundred feet away an immense sea monster that fully answered the description previously given of sea serpents. Captain Sherman says he had a perfect view of the monster. He described it as being over one hundred feet in length, and in some portions its body was as large around as a flour barrel. The head of the serpent resembled that of an alligator."

TRANSATLANTIC—"On March 15, there was launched, on the Clyde, the splendid twin-screw steamship *City of New York*, the first of the two liners now being built by Messrs. James and George

Thomson for the Inman and International Company, plying between New York and Liverpool. The Inman Company is well known to Atlantic travelers as providing in their floating 'cities' a safe and comfortable means of transit across the Atlantic. . . . It is expected that the speed of these vessels will be at least as great as the fastest liners now afloat, but at the same time speed is by no means the first consideration which the directors of the company have kept before them, the two paramount considerations being the safety and comfort of the traveling public."

BIG GUNS—"No less than ten of the large 9.2 guns made for the British government have recently failed at test, the inner tubes of nine having been split and the outer casing of the other fractured. This, we believe, is the style of gun that has of late been so urgently advocated by certain of our army and naval officers as necessary for adoption in this country, to the exclusion of all other kinds of ordnance. In the opinion of these wise men, all people who hinted at anything else were behind the age."

POSTAGE—"The New York *Journal of Commerce* and a great many other influential newspapers, we are glad to see, are advocating the proposed measure for reducing letter postage to one cent. They justly take the ground that, with the large surplus in our treasury, the post office business of the country need not be made self-supporting. . . . A great deal might be said in favor of free postage, as an educational factor, but what the public will be satisfied with for the present is a reduction of letter postage."

KNOWLEDGE—"Nothing could well be more forcible than Sir James Paget's exposition of the advantages of the study of science, and his vindication of even 'a little knowledge,' so that it be real and true as far as it goes, and has been made the property of the mind by a process of self-verification."

VENTILATION—"One of the great evils of civilization lies in the crowding together of large numbers of persons in confined spaces. This is especially the case with schools and with factories, but is not limited to those instances. . . . The only remedy lies in effectual ventilation, and there can be no doubt that in factories, schools, and all other places in which many persons live and work or study in confined space, the ventilation should be much better than it is."

TELEPHONE—"Taken up in the beginning as an incomplete experiment, a wonderful toy, the telephone has developed into an indispensable adjunct of commercial business. No city or town of prominence is now without its telephone exchange, furnishing a quick and certain means of intercommunication to the business community, and its radial system of suburban lines connecting the surrounding territory with the commercial centers."

ARMY SIGNALS—"With the very extensive fronts of the large armies of the present day, it is not always possible to communicate by telegraph, specially when two divisions are separated by marshy ground. In such cases the field signaling apparatus can be used to advantage. This is an optical telegraph which consists essentially of a triangular and a hexagonal piece of linen, which can be so arranged in different positions in relation to each other that full dispatches can be transmitted very quickly."

WHEAT—"The Texas wheat-growing counties report the increase of acreage this season at from 10 to 100 percent. The world's annual consumption of wheat is estimated at 2,165,000,000 bushels."

STRIKES—"Striking was one of the principal occupations of the laborers of the United States in 1887. According to an estimate in Bradstreet's, the total number of strikes for the year was 858, involving 340,854 workers."

MINE SAFETY—"A perfectly efficient and safe miner's lamp has yet to be provided, and colliery managers are still far from unanimous in their approval of an effective and at the same time harmless substitute for gunpowder and dynamite as explosive forces."

HOT WATER—"A system of hot water distribution is being introduced in Boston. . . . Hot water under a pressure of about 300 pounds to the square inch and heated to 350 degrees to 400 degrees is used. . . . It is proposed to use this system for steam heating, making use of reducing valves to diminish the pressure from the water pressure of 300 pounds to the square inch, allowing it to expand into steam."

AND NOW FOR THE FUTURE

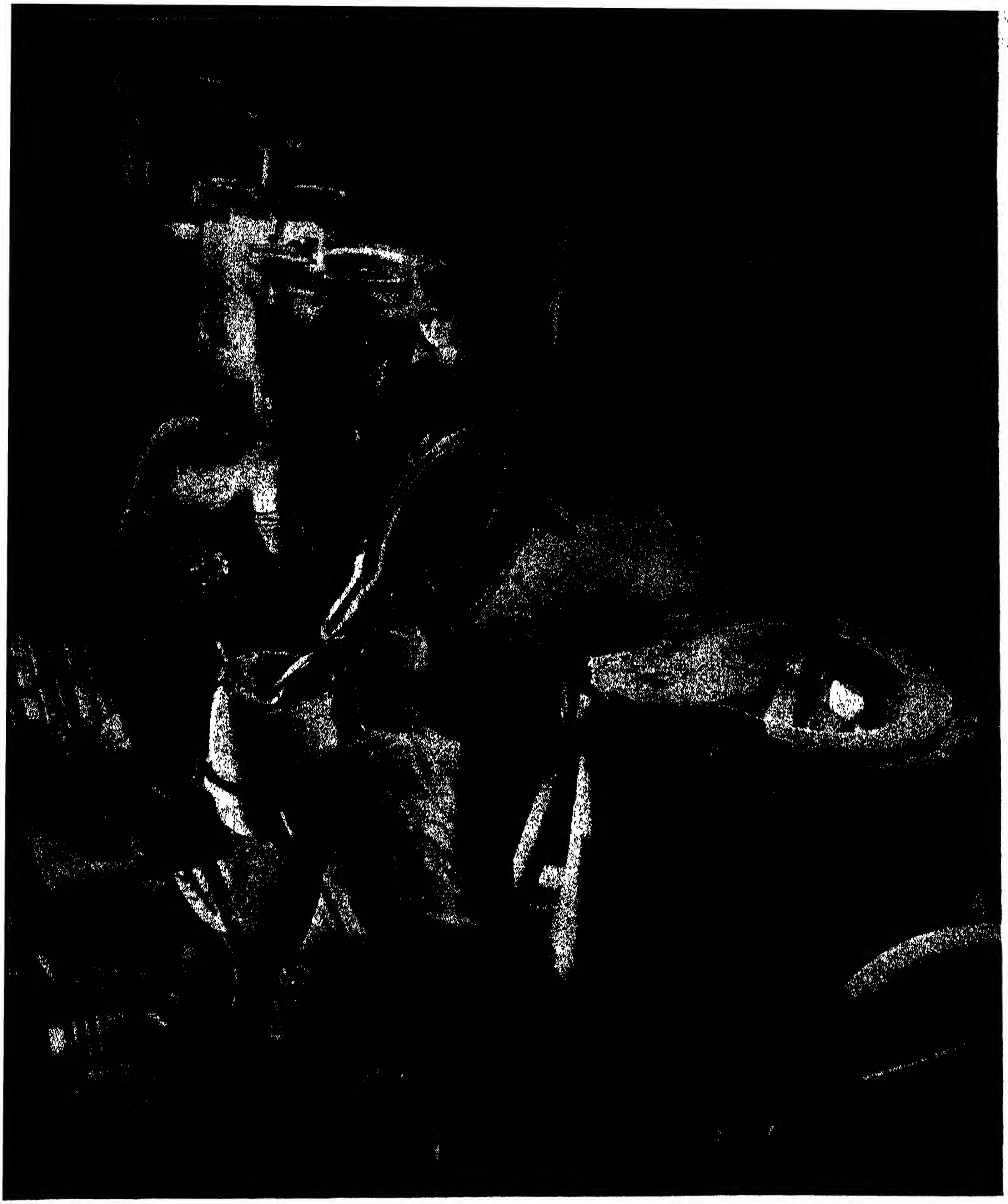
How climate and weather rule human affairs, by Clarence A. Mills, M.D., Ph.D.

Dr. Robert Hutchings Goddard, Number One Rocket Man, by G. Edward Pendray.

How the problem of naming colors is being solved, by John H. Crider.

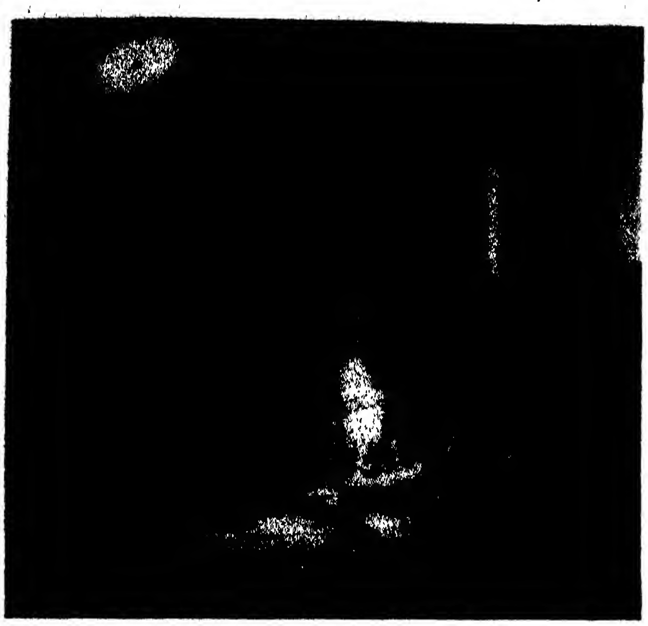
Flood forecasting in the Tennessee Valley, by Herbert F. Gough.

Micro-chemical analysis and what it does, by A. L. White.



MOLTEN STRENGTH AND LIGHT WEIGHT

FEW metals have a brighter incandescent whiteness when molten than aluminum, which is here shown being poured into graphite crucibles, or ladles, from which it will be poured, in turn, into prepared molds to make sand castings. Many oil-fired, tilting furnaces such as these are in the Cleveland works of the Aluminum Company of America, producing liquid metal from aluminum ingots. Thermocouples are suspended in the liquid mass of each furnace to determine pouring temperature.



Striking difference between local, or spot, and general lighting of work. Contrasts are so severe in the scene at left that seeing is hindered rather than helped by the single bright light. The vast improvement with general lighting is shown at right

INDUSTRY NEEDS MORE LIGHT

Plant Lighting Lags Behind Engineers' Knowledge . . . Designed Systems Speed Production, Decrease Spoilage and Accidents . . . Inexpensive

By A. K. GAETJENS
Nela Park Engineering Department, General Electric Company

IT is absurd to imagine men working in complete darkness, yet in a great number of industrial establishments employees do work under starvation levels of illumination that are little better than darkness when considered from a safety angle or from the standpoint of quick, comfortable, and accurate seeing.

The tremendous change in our living conditions which has been caused by the rapid increase in industrial occupations has not been accompanied by a corresponding ability of the eye to adapt itself to new conditions. Nature works slowly in adjusting mankind to his environment. For countless generations men lived by hunting or fishing and, later, by farming. These were outdoor occupations performed where daylight illumination ranges from 500 footcandles* in the shade of a tree to 8000 footcandles in the bright midsummer sunshine. Seeing was casual the greater part of the time; the objects to be seen, such as game, were at a comparatively long distance from the eyes; it was seldom necessary to employ the close coordination of eyes and hands to concentrate on fine detail which is so essential in many of our industrial operations today. When night came, man put away his weapons and slept. These are the circumstances for which the eyes were conditioned. Even with the advent of civilization there was little change in this mode of living until the end of the 18th Century.

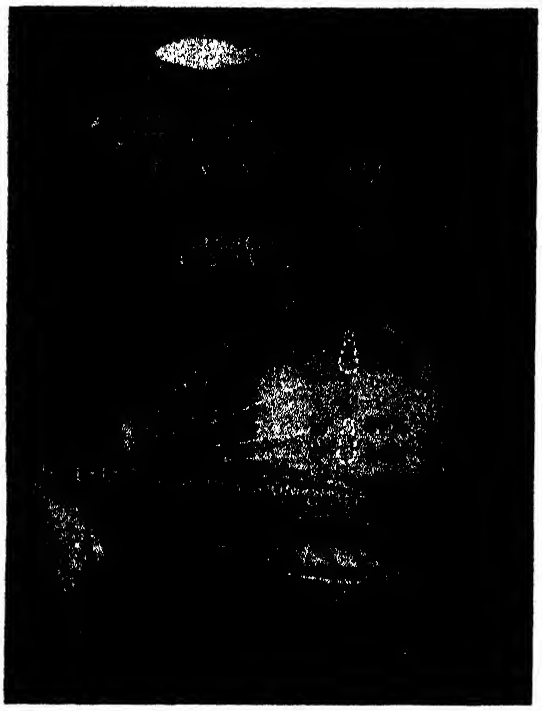
Today, however, industry has brought a great number of workers indoors where the demands upon their eyes are vastly different from the above conditions. From the extreme precision of interchangeable parts, even in heavy goods manufacture, to the fine delicacy of watches, modern methods demand that the eyes accurately coördinate with the hands much of the time. The eyes must also quickly and accurately discriminate fine detail. The work is usually within arm's length. The hours of concentrated attention are long. Most serious of all is the necessity of doing these difficult visual tasks under lighting that is negligible compared with outdoor light.

THE enormous development of the electrical industry in the past 50 years has given us a means of obtaining good artificial lighting. The illuminating engineer now has at his disposal light sources and equipment which enable him to plan a lighting installation which will aid the eye to see comfortably, efficiently, and easily. Fundamental laboratory research in conjunction with practical field studies is leading the way toward this desired goal.

Laboratory researches already completed in the science of seeing have led to methods whereby the illumination for any particular seeing task can be specified by quantitative measurements. The new Luckiesh-Moss Visibility Meter which is used for this purpose, for example, is an instrument which indicates how much light is necessary to see any particular object, based upon the factors of visibility which are involved. It is an extremely versatile instrument in the hands of a lighting specialist.

Few laymen realize the great differences in the ease of seeing common objects. They can be made to realize this in extreme cases such as reading a well-printed book, compared with the task of reading a 64th-inch scale, but under usual and less extreme circumstances these differences are not recognized. The accompanying chart indicates a number of work-world seeing tasks which have been evaluated to as-

*A footcandle is a standard unit of light measurement—approximately the quantity of light upon a surface one foot away from a sperm candle.



More general knowledge of the figures shown would prevent many abuses prevalent today

certain the quantity of light necessary for all of them to be seen with equal ease.

Although progressive manufacturers have realized the benefits of good lighting and are taking advantage of the studies of the Illuminating Engineering Society, it is unfortunately true that the great majority of American industries are still woefully underlighted. The cost of this neglect in the form of slowed production, excessive spoilage, poor and uncertain inspection, and industrial accidents is staggering. The fact that poor lighting is the cause of these difficulties frequently is not realized because the eye is so highly adaptable to many conditions. Secondary effects frequently are the only tangible results of the poor lighting except that, over a period of years, the eyes weaken and need correction. One of the illustrations shows the direct relationship between occupations and eye defects.

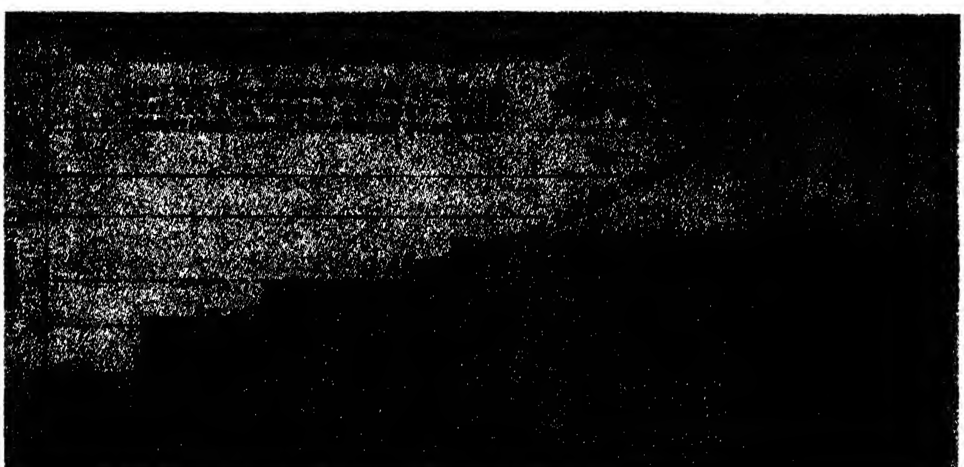
In the field of industrial accidents alone, Mr. W. Dean Keefer, Director of the Industrial Division of the National Safety Council, has estimated that poor lighting is probably the direct cause in 5 percent and a contributing cause in 20 percent of all industrial accidents, the annual cost of which is estimated to be 1,500,000,000 dollars. In 1936, according to the National Safety Council estimates, there were 18,000 fatal accidents, 70,000 permanent disabilities, and 1,460,000 temporary disabilities arising from gainful employment. Records of industrial accidents show that the average disability costs the employer 200 dollars in compensation, doctor bills, and hospital fees. In addition, there are added costs covering the value of lost production, labor turnover, damaged machinery and material, and other items which total about four times the direct cost. Thus, the average disabling injury suffered by a worker will cost the employee's company 1000 dollars. The prevention of one such accident would pay for the installation of good lighting over several thousand square feet.

Where good lighting has been installed, it is frequently found that the intangible benefits were fully as numerous and important as were those for which an accurate check could be made. Good lighting is the most natural of all aids to improve work because its assistance is not apparent. By making it easier to see, it helps the workmen to help themselves. The attitude of many employers who were visited in a recent survey of comparatively new lighting installations is typified by the following statement. Mr. F. A. McDermott, Factory Superintendent of Bastian Brothers Company, Rochester, New York, has this to say in regard to the unmeasured benefits of a good lighting installation.

"About six months ago we began to install improved lighting in our plant. Since we had decided to do the job right, complete rewiring was necessary, and for this reason the work of installing the new lighting covered a period of several months and, in fact, is still going on. . . . One thing has been evident from the day the first section of the factory was relighted: the men appreciate the difference between adequate and inadequate lighting. Those who already have the improved lighting have expressed their satisfaction with it, and those who are still working under the old lighting system are highly impatient to have their section of the plant relighted. This reaction on the part of the factory personnel is highly gratifying to the management—so much so that even if the improved lighting should bring us no other tangible benefits, its installation will be considered well worth while because of the improved morale of our employees."

In planning a lighting system, it is desirable, first of all, to provide a substantially uniform level of illumination throughout the room. This eliminates shadows in dark corners and makes the entire work area equally suitable for any desired arrangement of machinery and benches. Lighting units are spaced relative to their height above the surface to be illuminated. As this surface is usually a work level from 2½ to 3½ feet above the floor, it is permissible to plan the spacing of the units proportionate to their mounting height above the floor. Usually, a spacing distance which does not substantially exceed the mounting height from the floor will result in reasonably uniform illumination.

WHERE the lighting is very non-uniform, with extreme contrasts between bright and dim areas, the eyes continually try to adapt themselves to the various lighting conditions in the field of vision. Eyestrain usually results, and continued vision becomes difficult. Spotty illumination may be caused by one or more of the following conditions: Incorrect spacing of lighting units, the use of the wrong type of lighting equipment, or the use of localized lighting with no general illumination. This last factor is becoming more and more important as general lighting is being sup-



Seeing tasks evaluated by the Luckiesh-Moss Visibility Meter on the basis of footcandles needed, general and supplementary, to obtain equal ease of seeing in a wide variety of tasks

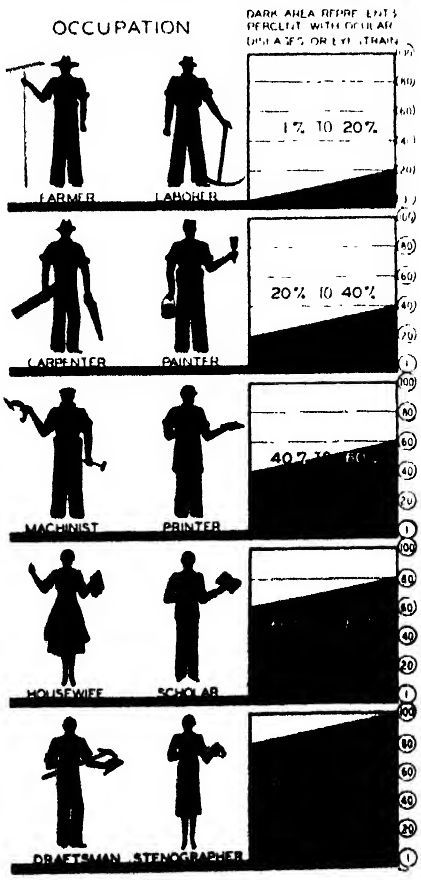
plemented with a considerably higher level of light at the work plane for tasks where seeing is difficult. Where this work is confined to small areas, the most practical way to provide for the increased footcandles is by supplementing the general illumination by a unit which gives additional light directly to the area in question. Where such lighting is employed, care must always be taken to provide sufficient general illumination so that the proper contrast conditions for visual comfort will not be exceeded. This can usually be accomplished by providing at least one footcandle of general illumination for every 10 footcandles of supplementary, or direct job-lighting.

The proper solution to the problem of supplying this special lighting involves not only the actual footcandles to be provided but also the proper method to employ, the equipment to use, and the location of this equipment with respect to the specific task. A well balanced combination is shown in an accompanying illustration.

Recommended Footcandles for Representative Industrial Operations

(These footcandle values represent order of magnitude rather than exact levels of illumination)

Operation	*Recommended Footcandles*
Assembling	
Rough	10
Medium	20
Fine	50-100
Extra Fine	100 or more
Inspection	
Rough	10
Medium	20
Fine	50-100
Extra Fine	100 or more
Machine Shops	
Rough Bench and Machine Work	10
Medium Bench and Machine Work, Ordinary Automatic Machine with Rough Grinding, Medium Buffing and Polishing	20
Fine Bench and Machine Work, Fine Automatic Machines, Medium Grinding, Fine Buffing and Polishing	50-100
Extra Fine Bench and Machine Work, Grinding Fine Work	100 or more
Steel and Iron Mills, Bar, Sheet and Wire Products	
Soaking Pits and Reheating Furnaces	5
Charging and Casting Floors	10
Muck and Heavy Rolling Shearing, Rough by Gage	10
Plate Inspection, Chipping	30-50
Automatic Machines, Light and Cold Rolling, Wire Drawing, Shearing, Fine by Line	15



An extensive survey revealed a significant relationship between occupations and eye defects which are in higher proportion in the vocations which involve difficult seeing tasks

Glare is one of the most detrimental factors encountered in the industrial work-world today, for a glaring bare lamp will decrease the effectiveness of any lighting system. In a broad sense, we are familiar with these facts. It is not comfortable to look at the sun when it is high in the heavens, neither is it comfortable to look at a sheet of water glistening in the bright sunshine. In looking at the sun, direct glare is encountered. The sheet of water in the bright sunlight is an example of reflected glare. Both are uncomfortable, and one instinctively turns away. But the industrial worker cannot look away from his task; he must keep his eyes upon it even though the bare lamp in his field of vision is uncomfortably bright and may also be reflected to his eyes, for example, by the polished metal upon which he may be working.

THESE factors are some which are collectively termed the quality of illumination or the quality of lighting. They are considerations that must be observed in order to obtain a good installation. However, in order that the light may aid productive effort most efficiently, it has been found that certain definite footcandle levels should be considered a minimum for the best lighting effect. Tables of recommended footcandles of illumination for various tasks have been made and are generally accepted as a guide to current practice. These tables are based upon practical experience and economic justification. A few excerpts are presented in the accompanying tabulation to indicate the range of footcandle levels now recommended in industrial lighting practice.

After a lighting system has been installed, it can be maintained at high efficiency only by a well-planned cleaning schedule. Dust and dirt inevitably collect upon the reflecting surfaces of the equipment and unless they are cleaned periodically the result will be an extremely inefficient installation. Even a barely discernible layer of dust frequently decreases the light output as much as 30 percent. For this reason, a schedule of cleaning the units with soap and warm water at intervals not greater than six to eight weeks in the average plant is highly recommended.

The lighting equipment serves to re-

Excellent visual conditions with 20 footcandles diffused general lighting plus supplementary lighting

Using the Luckiesh-Moss Visibility Meter to determine amount of light

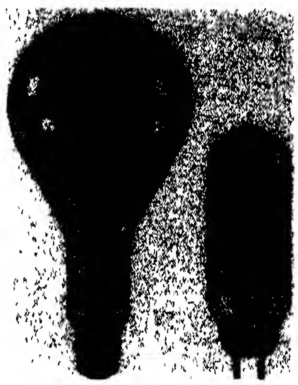
direct the light generated by the lamp filament. The filament itself can transform electrical energy into light efficiently only when the voltage upon it is equal to the voltage for which the lamp was designed. The economical production of light, therefore, requires wiring of sufficient capacity to carry electrical energy from the distribution panelboard to the lamp socket without excessive voltage-drop and power loss in the wiring. The importance of this step is shown by the fact that a 1 percent drop in voltage reduces the light output of an incandescent lamp about 3 percent and a 5-volt drop lowers it about 16 percent.

The difference between the initial cost of an undersized wiring job and one of thoroughly adequate capacity is not as a rule very great, and the subsequent saving is sufficient to make it profitable in industry. In general, wiring to carry double the indicated load can be installed initially at about one third extra cost.

An entirely new technique has been developed to manufacture the 1000-watt, 750-watt, and 500-watt medium bipost lamps which have been announced recently. The 1000-watt lamp has a decided advantage over the older type of lamp from the standpoint of physical size. Its other advantages are equally outstanding. The hard glass bulb will withstand water drops and juicy insects better than the older lamp. The use of a screen in the new lamp reduces blackening on the sides of the bulb to a great extent. This is so effective that the overall maintenance of illumination at the end of the life of the new bulb is appreciably better than that of the former lamps at 50 percent life. The small-size bulb permits the use of smaller and less expensive reflectors to obtain the same distribution of light.

In addition to the bipost lamp development, the past three years have seen a remarkable acceptance of the new mercury lamps. When equipped with the proper transformer or reactor auxiliary, this type of lamp can be used on either 115- or 230-volt alternating current circuits. The initial efficiency is approximately twice that of comparable wattage incandescent lamps, while the rated life is 2000 hours. The lamps are tubular in shape.

The light emitted by these lamps has the characteristic line spectrum of mercury, in contrast to the continuous spectrum of the incandescent lamp. This means that all of the light is represented by only a few lines which produce yellow, green, and blue light. Although the light from the lamp appears blue, it also is very rich in the yellow-green lines. This attribute makes it a very good source to use in combination with incandescent lamps. The mixed light appears similar to daylight although it will accentuate certain colors and is, therefore, not suitable for critical color discrimination.



Old type 1000-watt lamp and new 1000-watt bipost lamp

The leading lighting equipment manufacturers have developed direct and indirect, distributing and concentrating types of units for use with the mercury lamp or combinations of mercury and incandescent lamps.

The cost of both lamps and equipment has been constantly decreasing while their efficiencies have been increased materially. The cost of electrical energy also has consistently shown a downward trend. As a result, the lighting dollar now purchases 10 times as much light as it did 25 years ago and twice as much as it did only 10 years ago. In addition to this marked improvement, newly developed methods of applying light most effectively for visual well-being still further increase the actual value of light.

In order to have a sound basis on which lighting costs and economics may be studied, the following analysis of manufacturing costs is presented. These are average figures for all types of industries, and any one industry or any one plant may vary somewhat from these quotations. The major accounting items of the total production cost are distributed as follows: Salaries, 5.9 percent; labor, 16.5 percent; raw materials, 52 percent; fuel, light, and power, 2.7 percent; miscellaneous (including such items as advertising and sales cost, insurance, taxes, interest, depreciation, workmen's compensation, and profits), 22.9 percent. If the percentage representing the lighting alone is separated from the fuel and power cost item, it appears as only 0.3 percent of the value of the manufactured product. This means that for every three dollars' worth of goods sold, one cent is paid to enable the worker to see what he is doing.

From such a cost analysis, it is apparent that while good lighting can effect a valuable improvement in working conditions which benefits every phase of plant operation, actually it represents a very minor part of the operating costs of the business.

Modern high-level illumination. Between the old 1000-watt lamps, 400-watt mercury lamps were interspaced. Result: 40 footcandles of white light on the work

OUR POINT OF VIEW

Research

MORE than passing strange, we continue to hear indictments of the machine as the true cause of all our economic woes. This fiction, this hallucination, will not down. It is worse than futile to counter with figures definitely proving that this is not the case or to ask for proof of the accusation; the shades of the Technocrats still clank their chains and continue to frighten timid souls. And as that fright may be measured, by so much is real progress retarded.

Now, on the other hand, a member of Congress states, in effect, that two to three million men would be given jobs if 200 scientists and engineers would each create an invention in 1938 that would start a 40,000,000-dollar industry. It sounds exciting. And it is—all of that and more! But—who is to supply the formulas for the inventions? Who will select the 200 most-likely-to-succeed heroes? Who will guarantee their year's work to be worth, industrially, 40 million or 40 thousand or 40 cents? And how shall we be sure that, like a division of soldiers, they won't all shoot at the same target?

Perhaps, however, the thought was that all research men, all engineers, should work hard and purposefully toward creating industries, and maybe 200 would succeed. If this be so, one can criticize this Congressman for nothing more than repeating a truism, for superfluity of language. For, if some people are not already aware of the fact, there are in this country numerous industrial and institutional research organizations humming with the intense activities of many thousands of "professional inventors" whose one aim is to improve industry. They do not say, each to himself: "I am going to invent one thing before the end of the year which will found a 40,000,000-dollar industry." Instead, each drives ahead, solving some part of an industrial problem on which others may also be working; and in the end a new product is born, an old one is vastly improved, or a better, more efficient way of producing it is worked out. The result of the work of this mighty army of superior thinkers is improvement all along the line and a steady, if slow, growth of business and employment figures. Besides this group there are, of course, numerous free-lances in this business of developing new products and improving the old; and though their work is more casual, they make many outstanding inventions each year, some of which establish great industries.

We don't believe that research men have envisioned more than a fraction of the work that is to be done. Still, if they, trained specialists, need a formula, then it is they who will supply it; certainly no layman can have more than a smattering of knowledge of their problems, the things they should do. It is in a sympathetic understanding of the enormous benefits of scientific research that the layman can shine. The abovementioned Congressman can best do his share for the well-being of the country at large by fighting for an expansion of governmental scientific research which has been badly curtailed these past few years.

Reassurance

DEADLY and horrible as it will be when—and if?—the next world war comes, there is some consolation to be derived from facts learned from certain military failures in Ethiopia, China, and Spain. In these three brutal reversions to savagery, science, as expressed in the newer machines of war, has not always shown up so efficiently as a maker of military advantage. Some of these facts will bear repetition.

In Ethiopia, optimistic predictions of attacking commanders put the invading army in Ethiopia's capital in little more than marching time. Months later, despite vastly superior equipment, airplanes, tanks, guns, and even war gas, the invaders were still fighting bloody infantry battles far from their goal.

It is in Spain, however, that the calculations of the strategists have suffered their most serious upset. Both sides in this fraternal strife have been well supplied with tanks and the most modern fighting and bombing planes. Yet neither of these devices has proved as successful as was to be expected. As pointed out in *Army Ordnance* by Captain Liddel Hart, the great speed of the planes has militated against their efficiency, and mud has proved the nemesis of the tanks. Planes bombing bridges, rail-heads, and other important military objectives have failed generally to accomplish their destructive purpose; their very speed has made their marksmanship poor and their bombs have fallen far from their targets. Their real effectiveness has been as frightful *strafers* of civilian populations and as a means of lowering the morale of troops. As for tanks, it appears that they have licked the problem of mud no better than those dozen or so we saw bogged down in the shell-churned mud opposite Verdun in 1918.

In China, poorly equipped and poorly trained Chinese held off the Japanese at Shanghai for weeks although the latter used every modern device of warfare including the big guns of naval vessels firing at point-blank range. Superior equipment and training of the Japanese finally pushed back the Chinese, but very slowly indeed, and at what a terrific cost to the invaders in men, munitions, and planes! In the beginning, conquest seemed an easy matter, yet it begins to look as though mere men and rifles of the Chinese may hold off the Japanese until they are worn out and decide to quit.

No matter how one looks at it, these three wars are horrible to consider. Yet in no one of them has the promise of a civilization being wiped out by machines shown any evidence of fulfillment nor even has there been evidence of the irresistible march to victory that one who has listened to the scare-mongers would expect. True, the use of gas has been avoided—for fear that such use would alienate world friendship irrevocably for the offending user—but gas is not so deadly as some people think. There is in existence no gas, usable in warfare, that will wipe out cities; in fact, the military gases used 20 years ago in No-Man's Land are still the best for their horrendous purpose.

Yet if all this is reassuring as to the relative inefficacy of the machines of war, there remains to be considered the human factor, the woeful savagery of the military mind. This has shown itself in the lowest form of bestiality in all three of these bloody affrays in a total disregard for the humanities. Prisoners of war have been murdered in cold blood; thousands of civilians have been destroyed, principally by airplane bombs, for no military purpose; and all manner of un-military cruelties have been perpetrated in the name of national honor, national face-saving, and furtherance of megalomaniac ideologies.

At this point in civilization's retrogression, the democracies of the world seem to be the last hope for the preservation of some semblance of "humanitarian" warfare. Already powerful voices are being raised for that purpose. We hope they will wax more powerful. Whatever the final result will be—whether an agreement among the nations or the not-to-be-disregarded pressure of mass opinion—some progressive step, some definite action against further destruction of noncombatants must be taken soon lest civilization perish in the ashes of its own consuming fires of fury.

NEW LIGHT ON THE SUMERIANS

Though Science Remains Ignorant of Their Origin, Recent Archeological Discoveries Have Increased Our Knowledge of this Mysterious Ancient People

By E. A. SPEISER

Professor in the University of Pennsylvania and Director of the American School of Oriental Research in Baghdad

THE Sumerians have long been the problem child of Oriental archeology. Unlike the Hittites or the Horites, they were not foreshadowed in the Bible. Their appearance on the scientific stage was not linked with the discovery of lost empires, for it was neither sudden nor dramatic. They insinuated themselves, so to speak. It was years before the very existence of the Sumerian

Figure 1: **The altar of the shrine, dedicated to Abu, god of fertility**

language and a Sumerian people was definitely established. Today Sumerian records can be read with comparative ease. The known cultural achievements of the Sumerians are numerous and of fundamental importance to civilization. But the list is as yet far from complete. We are still in the process of discovering the people.

Ancient Mesopotamia used to be regarded as the private and exclusive battleground of the Babylonians and Assyrians. Increasing knowledge of the available evidence showed that the Biblical estimate of the country accords better with the facts, for the Land of the Two Rivers has never ceased to justify its description as a Tower of Babel. The oldest historic times already yield a picture of many languages and many races. The Semitic Babylonians were but one group out of many. By 2000 B.C. their language was the official tongue because its speakers ruled the land, but for scientific and religious purposes another language was commonly employed, much in the manner of Latin in the Middle Ages. That language was Sumerian. It had become a "dead language" 4000 years ago because the Sumerians themselves had disappeared by then as a political power, and evidently also as a race. But their influence persisted. In the Orient it has continued ever since, and in some respects it has pervaded even the western civilizations of today.

AT all events, Sumerian political history is not later than the third millennium B.C. Indeed it is from that period that we get our fullest information about the Sumerians. We see them as founders of city states and as capable civil and military organizers. They were efficient farmers and accomplished craftsmen. They had evolved an elaborate and humane code of law, and religion had come to play a vital part in the lives of kings and subjects alike. Above all, the Sumerians were a highly literate people. Writing on stone and on clay tablets was used to commemorate important political events, the erection of public buildings, the closing of a business transaction; many inscriptions bear a religious character. To this literary activity of the Sumerians we owe our knowledge of contemporary history and institutions. We know the names of the various rulers and frequently their dates, and we have a fairly clear picture of a number of peoples with whom the Sumerians lived and fought and traded. Naturally, we now have a satisfactory understanding of the Sumerian language. That language is neither Semitic nor Indo-European. All attempts at connecting it with other known languages have proved futile. For this very reason we are in the dark in regard to the background of the Sumerians. The statements that are occasionally made in writings of a popular character, that the Sumerians were Semites, Aryans, or a mixture of both, are absolutely without foundation. The origin of the people remains a mystery.

The problem is twofold: When did the Sumerians arrive in Mesopotamia and from where did they come? On the latter point we are no better informed now than we were ten years ago. But recent archeological discoveries have shed fresh light on the antiquity of the people. First came the justly famous Royal Tombs from Ur. They were unquestionably Sumerian and they date from shortly after 3000 B.C. To be sure, it has been known for some time that the Sumerians were at least as early as that. But the high level of their civilization as revealed by the Royal Tombs was certainly unexpected. There is nothing nearly as early that equals those grave furnishings in wealth, variety, and sophistication. The jewelry is remarkable and the carving on cylinder seals unexcelled. Most impressive, however, is the metal work. Egypt had to try for centuries before she could produce objects in gold, silver, and bronze comparable with the handiwork of the Sumerian smiths from Ur.

But 3000 B.C. is a comparatively late date in our recently reconstructed picture of the ancient Near East. At Tepe Gawra, in the north, that date is represented by Level 7. Below it there are at

Figure 2: **Statue of a bearded dignitary, with eyes of lapis lazuli**

least 16 earlier strata. The Sumerians may have settled on the alluvial plain of Southern Mesopotamia at any time in the fourth millennium without becoming thereby the earliest population of the country. All we can say with certainty today is that they must have come in by the middle of the fourth millennium, for it is at approximately that time that we get in Uruk, the Biblical Erech, the earliest written records known to man, and these records have turned out to be Sumerian. It is a fair and logical assumption that the Sumerians were responsible for the invention of writing, perhaps the greatest single contribution to human progress. All remains preceding the invention of writing must necessarily be anonymous. And so the question as to the exact date of the arrival of the Sumerians remains unsolved, for the time being at least.

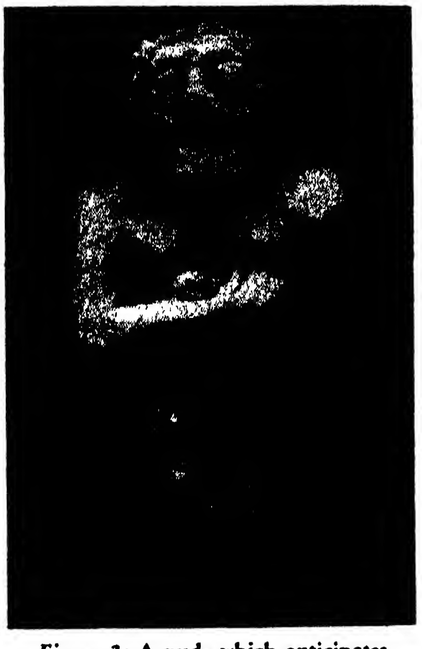


Figure 3: **A nude which anticipates the classical statues of Hercules**

Our present approach to the problem of the Sumerians concerns itself not so much with the question of their origin as with the sum of their achievements. The list of these, it appears, is not likely to be exhausted for a long time to come. Each season brings its own quota of contributions. The latest have come from a group of mounds to the northeast of Baghdad, close to the Diyala River. The new material introduces the Sumerians as expert sculptors at the very beginning of recorded history. It gives us also a new insight into the part which athletic contests played in the religious practices of 5000 years ago.

Until last year the excavations in the Diyala area were conducted by the Oriental Institute of the University of Chicago. Under the direction of Dr. Henri Frankfort, one of the leading archeologists of our day, the mounds of that region, including Tell Asmar,

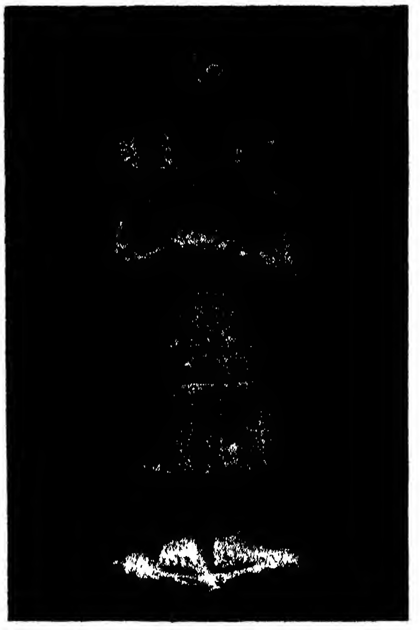


Figure 4: **A curious case. Why was this man's beard chiseled away?**

Khafaje, Ishchali, and Tell Agrab helped to add several centuries to the known history of the Sumerians. The dating of the whole period around the turn of the fourth millennium B.C. was placed on a sound basis, the age in question having proved to be Early Dynastic; that is, the time of the first known dynasties in the land. It coincides, interestingly enough, with the first Egyptian dynasties. Three definite stages of Early Dynastic were established by the work of Dr. Frankfort and his staff, each stage requiring not only several building levels of its own but disclosing also internal changes in art and architecture. The Royal Tombs of Ur fall within the third and latest phase. The bulk of the material is earlier, about 3000 B.C. in round figures.

THROUGH Dr. Frankfort we were invited to take over the concession. We were engaged, however, at the time, in the excavation of Tepe Gawra, nearly 300 miles away from the Diyala concession. At length the invitation was accepted and the Joint Expedition of the American School of Oriental Research in Baghdad and the University Museum devoted a month to the excavation of Khafaje, one of the principal mounds on the Diyala. The success of that venture is due in a large measure to the fullest possible co-operation on the part of the Oriental Institute and the Iraq Department of Antiquities.

The principal group of finds is composed of sculptures in the round. Most of the sculptures discovered by us came up in a small shrine dedicated to the god of fertility. This identification is supported by a pair of animal horns carefully embedded in bitumen before a sacrificial podium. Since horns are known to have been symbols of strength and fecundity, there can be little doubt that the Sumerian god of fertility, called Abu, presided over this particular shrine. Similar shrines were discovered by Dr. Frankfort at Tell Asmar, where they were identified by inscriptions as belonging to the god Abu.

The sculptures were concentrated in two places. One of these was the altar of the shrine (Figure 1), the sides of which were regarded by the devotees as convenient repositories. The other was a shallow pit in front of the altar. The statue was the representative of the donor, calculated to remind the deity of the suppliant's presence. This is obviously the reason why so many of these statues have been preserved; they were treated with reverence and thus escaped the fate of so many other types of objects. A later generation might bury them in order to remove them from

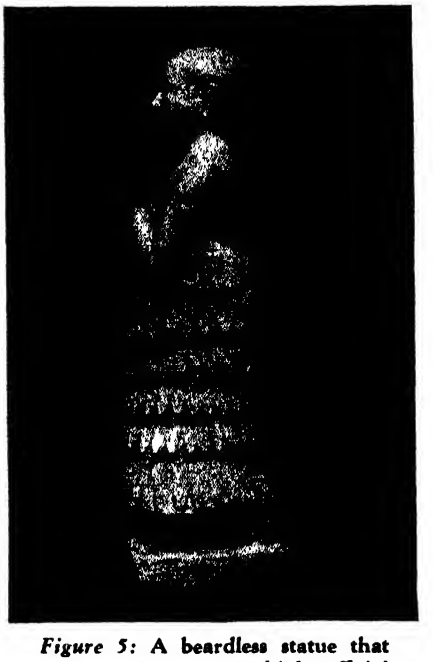


Figure 5: **A beardless statue that may represent some high official**

sight, but they were not destroyed or re-used for other purposes.

The statues portray both bearded and beardless men. The commonest specimens would show a portrait in grey marble of a bearded dignitary wearing a flounced skirt, with hands clasped in front and eyes made of inlaid shell and lapis lazuli (Figure 2). The presence or absence of beards was not merely a matter of fashion. The occurrence of the two types side by side has a deeper underlying significance. Years ago, when the available material was scanty, it used to be held that the bearded figures represented the Semites, the beardless ones the Sumerians. But when a number of ancient gentlemen with unimpeachable Sumerian antecedents began to sport beards, it became clear that the reason for the custom was religious. Priests, and kings who combined secular and religious authority, wore beards as the

Figure 6: **A bout that took place 5000 years before the days of Joe Louis. The three boxing scenes shown should be read from right to left, not left to right**

prerogative of their office. This interpretation is borne out by the present material. For, in addition to ordinary portraits, we have also interesting nude figures (Figure 3) which could scarcely be representative of average citizens or even of officials. They belong clearly in the temple, and they are just as clearly bearded.

One statuette (Figure 4) resembles the other members of the bearded clan save in one respect: of the original beard only the sidelocks have remained. The rest was cut off as is shown clearly by the none too delicate chisel marks. Had the man lost his priestly office after sitting for the sculptor, so that the beard too had to go? This seems improbable because priestly offices were usually hereditary. Or do we have here an instance of domestic difficulties? The wife may have objected to the apparition so strenuously that the poor wretch had to resort to a compromise for the sake of peace. Who knows?

THE beardless statuettes are made of marble or of alabaster. In all likelihood they represent high officials. They differ from the foregoing also in one other respect. The workmanship is here plainly superior, the likeness less conventionalized. An excellent example of this naturalistic style is furnished by a small statue of grey marble (Figure 5). The man is dressed in an elaborate flounced skirt although he is nude from the waist up. The hands, which are now partly broken, were once clasped in the manner customary to worshippers, but the left foot is moved slightly forward; our friend seems somewhat impatient with the whole ceremony. The back is beautifully modeled. The head is a little masterpiece of naturalistic portraiture. The mouth attempts a smile, but the expression is arrogant rather than kind. The left eyebrow is raised quizzically, accentuating the suggestion of superciliousness. Although the figure is almost

Figure 7: **Why did these two wrestle with immense vases on their heads?**

slender there is a distinct double chin, and a fold of fat on the neck, just below the skull, conveys an impression of stubbornness if not cruelty. Large ears round out the picture. It is not a pretty one. All the more credit, therefore, to the nameless sculptor who succeeded in pleasing the vain and self-satisfied subject, while laying bare before us his character in all its nakedness. In a work of 5000 years ago this is certainly a revelation.

Two other objects from our last season's work at Khafaje cannot be left out of this account. The first is a limestone relief which has not come down to us in the best possible state of preservation. It consisted originally of more than one register, with several scenes depicted on each panel. What we have now (Figure 6) is the lowest register alone, and even this is partly damaged. It consists of three scenes. Viewed from right to left, the first scene shows two men in what is unmistakably a boxing match. The men are sparring, their outstretched arms keeping each other at a healthy distance. The hands are bandaged, but in the present condition of the relief further details cannot be discerned. So far everything seems to be going according to the approved modern rules of the game. The situation changes, however, in the middle scene. Here one of the contestants has been lifted off his feet and his defeat appears to be not far away. In the third scene the action is even more violent. Some kind of ankle-hold is plainly visible to us, and it could hardly have escaped the referee. It must have been legal in ancient Sumer. How the match ended is anybody's guess, because the rest of the relief is broken, thus sparing us the final details, perhaps mercifully.

The ankle-hold may have put us in a mood for wrestling. We do not have far to go, for a legitimate wrestling bout is suggested by another object, this time of bronze (Figure 7). The two opponents are nude except for the scantiest belts. Each tries to secure a hold without losing his own footing. The leg muscles betray the strain which the expressionless faces attempt to conceal. The huge vases on the heads of the wrestlers are a puzzling feature. The only excuse for these staggering appendages is that the bout was part of a religious ceremony. The same is true, of course, of the boxing scenes, inasmuch as both objects were recovered in a shrine. The precise implication of the vases is open to speculation.

ONE feature of this wrestling group is of considerable technical interest. The bodies were cast in a mold, but the hands had to be added afterwards, since no ancient mold known to us could produce the whole group as it stands. Nonetheless, this composite work did not impair in the least the effectiveness of the tableau.

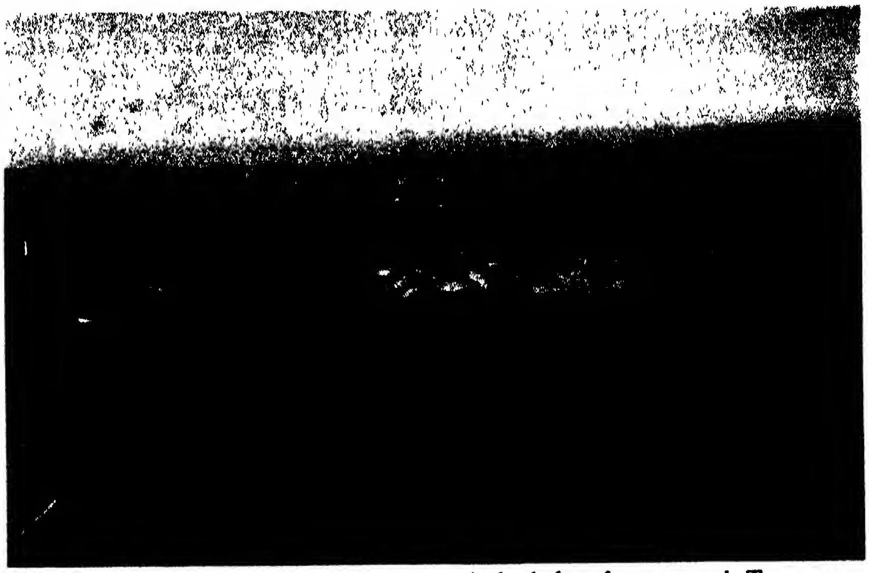
Our brief excursion into ancient Sumer, away from the immemorial past of Tepe Gawra, thus produced results of more than usual interest. The numerous statuettes recovered add greatly to our knowledge and appreciation of early Sumerian sculpture. The naturalistic examples are especially significant, both because a short time ago sculptures in the round were not thought to exist as far back as the turn of the fourth millennium, and also because for sheer frankness these statuettes would be difficult to excel. The athletic specimens push back the history of such contests to an equally remote age and give an entirely new meaning to the term "ancient" when applied to sports.

And so we keep on finding out new things about that remarkable people known as Sumerians. But the answers to two questions still elude us: Where was the original home of the Sumerians, and when did they first appear in Mesopotamia?

Trees On a Salty Isle

IN February, trees were planted upon a 400-acre rectangle of black sand that lay, less than two years ago, on the bottom of San Francisco Bay, which is as salty and unfriendly to delicate vegetation as any harbor bottom in the world.

By February of 1939, this man-made island, site of the Golden Gate International Exposition, will be a lush garden of sub-tropical plantings, the roots of which will never suspect that they are in an environment that would have been sure death a little earlier. Then by February of 1940, the trees will be gone; this 400-acre island in the center of San Francisco's harbor will be barren again, for it will be an airport, and no transport plane ever took off from a forest, or landed in one with any success.



San Francisco and the Golden Gate serve as the back-drop for man-made Treasure Isle, in the middle distance, which must be de-salted before vegetation will grow

Behind this unnatural life cycle of 1,500,000 dollars' worth of vegetation is the story of science, once again taking Mother Nature to the cleaners; and in this case-history, Mother Nature will help to defeat her own laws. For the "leaching" of the World's Fair island will in all probability be accomplished entirely by natural rainfall during the California winter rainy season of 1937-38.

Exploratory drillings on Treasure Island, which was dredged up by United States Army Engineers to a height of 13 feet above mean low water, disclosed that a "dome" of salt water remained in the saturated fill. Around the edge of the island, rapid drainage had drawn the salt water nearly down to the tide level, but in the center, where drainage is slower, the water-table was at a higher elevation.

Late in 1937 began the installation of 200 well-points, jetted down 20 feet into the sand. Salt water, gathered through slotted screens, was to be pumped to the surface for some 60 days and shot back into the harbor through the island drainage system, more than six miles of redwood stave pipelines.

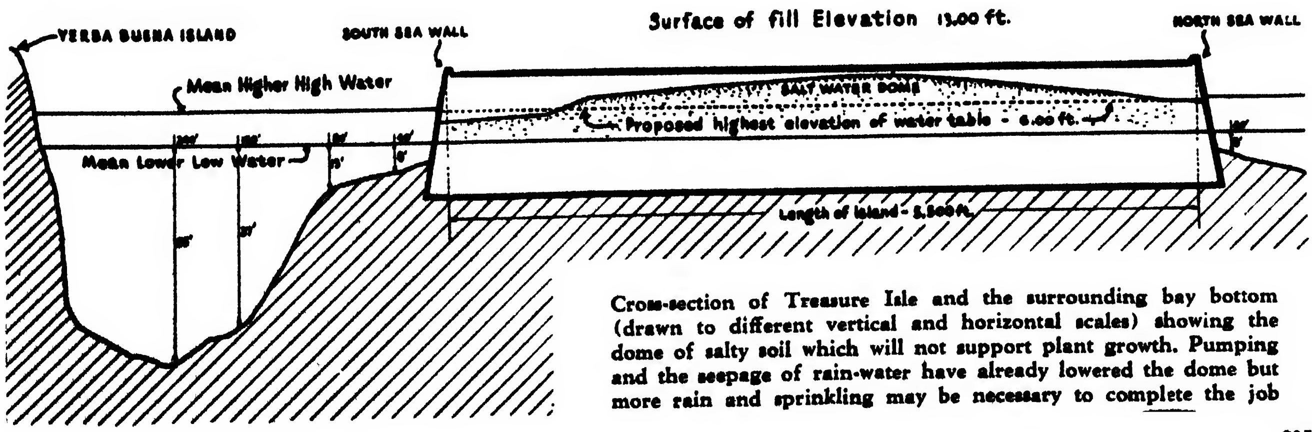
Laboratory tests have proved that this lowering of the salty water-table reduces the salt content of the sub-surface water from its original 5000 parts per million, down to 1000 parts. Natural seasonal rainfall, applying from six to nine inches of fresh water, further reduces this salt content from 1000 to 100 parts per million, other tests have shown, by washing residual mineral salts deep into the fill.

MORE than 90 percent of the trees, plants, and shrubs to be installed on Treasure Island have a saline tolerance greater than 100 parts per million. Areas in which the delicate 10 percent of the planting will be made are to be treated with commercial fertilizer, reducing the salt content to 50 parts per million.

During the winter rains, this process of pumping the salt water to flatten the "dome" continued, with frequent tests to determine the salinity of the sub-surface fill. If rainfall fails to provide sufficient water for leaching, fresh water may be applied by sprinkler systems to complete the cleansing.

Late in January, according to the schedule worked out by W. P. Day, Vice President and Director of Works for the Exposition company, barge delivery of 80,000 cubic yards of rich top-soil began. This loam will be spread from nine to twelve inches deep over the planting areas, and will suffice for the roots of all but the larger plants and trees.

Most of the 4000 trees will remain in their boxes during the 288 days of the Western World's Fair, from February 12 to December 2, 1939. The transplanting program began last February around the perimeter of the island where the water-table had already been lowered.



Cross-section of Treasure Isle and the surrounding bay bottom (drawn to different vertical and horizontal scales) showing the dome of salty soil which will not support plant growth. Pumping and the seepage of rain-water have already lowered the dome but more rain and sprinkling may be necessary to complete the job

THE ODD NEW-OLD STAR

The Much-Talked-of Huge Star in Auriga Yields to Astrophysical Interpretation: an Eclipsing Binary With an Almost Grazing Type of Eclipse

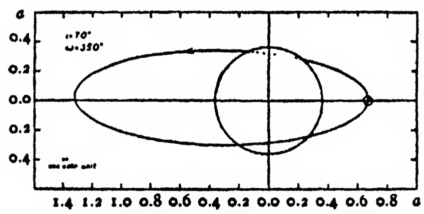
By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington.

AMONG the reports of astronomical investigations presented at the meeting of which we told last month, one was of such unusual interest that it was reserved until it could be adequately described. Since then, the detailed technical discussion has been published, the daily press has spread the news, and all the world knows that a star of extraordinarily huge dimensions has been discussed by astronomers at the Yerkes Observatory—Kuiper, Struve and Strömgren. These three justly distinguished investigators have done a most interesting piece of work; but when popular report credits them with the "discovery" of this star, it is more than a century behind the times.

Epsilon Aurigae is a star of the third magnitude, easily visible to even a casual looker-on, and very easy to find in the sky. The brilliant star Capella is at one corner of an irregular pentagon—one of the star-figures which any one would notice at a glance. The star we are discussing is next to Capella, at the end of a short side of the polygon. The next corner beyond is formed by a pair of stars of which the outer one, Zeta Aurigae, is another very remarkable system, which we described some time ago. Curiously enough, the star at the corner on the other side of Capella is also an eclipsing variable, Beta Aurigae.

ALL four of these stars are binary systems of unusual interest; but Epsilon Aurigae is the most remarkable and the most puzzling of them. Its variation in brightness was first noticed in 1821 by a German clergyman, Fritsch, who noticed that in the spring of that year it was much fainter than its neighbors at the next corner of the pentagon. Not much came of this for years, but in 1847 Heis observed it faint again, and his observations put its variability beyond doubt. Schmidt—a most devoted observer—made nearly 5000 observations of its brightness between 1843 and 1884; but the real nature of the variations was not discovered till 1902, when Ludendorff showed that the periods of faintness, each lasting more than a year, had come at regular intervals of 27 years, in 1821, 1847-48, 1874-75, and 1901-02, and could be explained by eclipses of a system with this period (then enormously larger than for any other eclipsing pair). The next eclipse, in 1928-29, came off on time, and observations of radial velocity in the interval have shown conclusively that the bright star—which alone shows on the spectrograms—is moving in an ellipse with this period. The latest discussion, by Struve, of observations covering more than the whole period, shows that the eccentricity is 0.33, not large for a double star of this period, and that the bright star is 2,500,000,000 miles closer to us on the near side of its orbit than on the far side. Only the part of the motion which affects the distance from us is revealed by the spectroscope, and, if the orbit is not edgewise toward us, its real diameter must be still greater. From the spectroscopic observations, the time can be computed when the bright star ought to be behind its companion, and this time agreed almost perfectly with the observed time of minimum. These facts (first brought out by Ludendorff in 1924) make it morally certain that the minima of Epsilon Aurigae are really due to eclipses.



The projected orbit of Epsilon Aurigae, showing the smaller, hot star whose orbit passes almost grazingly behind the far larger, dull red, cool star. Reproduced from the paper by Kuiper, Struve and Strömgren, in *The Astrophysical Journal*, December, 1937, pp. 570-612

But these eclipses are very remarkable. It takes the star more than six months (190 days, to be more precise) to fall in brightness. Then it remains constant, and a little less than half as bright as usual, for 330 days (almost a year!) and returns to normal at the same rate as it decreased. The form of the light-curve agrees perfectly well with what would be expected from the total eclipse of one star by another nearly three times as big and not quite so bright. There is no trouble so far, but, as long ago as 1912, Shapley showed that on the eclipse hypothesis the mean density of the larger star, which is in front at the eclipse, must be less than a hundred-millionth part of that of the sun, or less than 1/100,000 that of ordinary air. Nowadays we know of other stars of such low density—though hardly as low as this—so that this result can no longer be raised as a serious objection. But a far more serious difficulty was raised by Ludendorff at the same time. If the eclipse is total, the two stars must be almost equally bright; but the spectra show the lines of only *one* body, and during the "total" eclipse the *same* spectrum continues to be visible. As the eclipsing body is so much larger, it must shine more feebly per square mile—1/10 as much, at best—and we would expect it to be cooler, redder, and show a quite different spectrum. Moreover, the star should appear redder at minimum; but precise observations, made during the last minimum, show that its color does not change.

AS the star begins to lose its light—and even a little before—changes in the spectral lines occur, such as would be anticipated if the big star was surrounded by an extensive and very thin envelope in which additional absorption took place. Similar changes have been observed in Zeta Aurigae, where a small star is eclipsed by a big one, and in this case they are easily explicable. But in Epsilon Aurigae the additional absorptions still show after the light has become constant, and, on the simple eclipse hypothesis, the smaller star is completely out of sight!

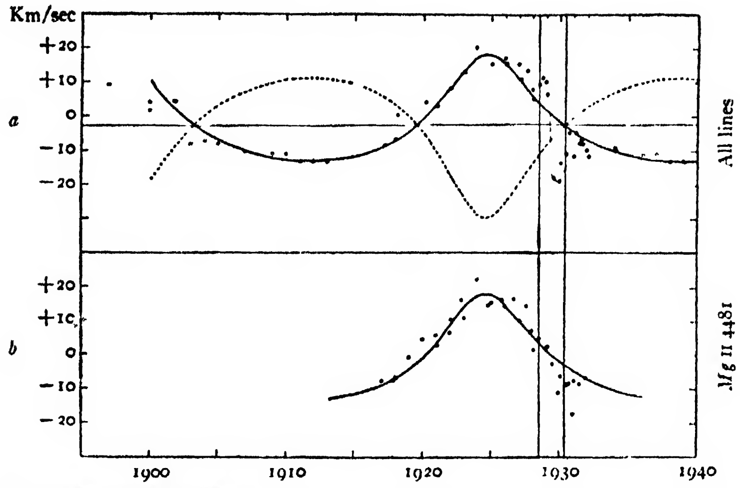
This last set of facts suggests that the larger star does not give out perceptible light of its own, but that its outer parts are partially transparent. As the smaller star goes behind them, its light is gradually weakened—like the sun's as it gets low in the sky and comes through more air—while (as in the case of sunlight) its spectrum remains substantially the same, with the addition of some lines

absorbed by the atmosphere. This hypothesis accounts for the loss of light without much change of spectrum; but any ordinary gas would obstruct blue light more than red, and so lead to conspicuous changes of color—like the setting sun. Even if some sort of "gray" atmosphere could be found, which weakened all colors equally, the more difficult problem remains to explain how this could cut out more and more light as the star sank behind it—and then suddenly stop doing so, and obstruct the same amount of light, even though the rays passed through a greater thickness.

A most ingenious solution of this puzzle is the contribution of the Yerkes team of investigators. Dr. Kuiper leads off by showing that, if we assume that one star goes almost centrally behind the other, we are led to inadmissible conclusions when we calculate the actual size and mass of the bright star. Assuming that the well known relations between mass and luminosity can be extrapolated so far, he finds that a central transit demands that the brighter star shall be 160 times as massive as the sun and 600,000 times as bright. By assuming that the orbit is inclined, so that the smaller star just dips behind the edge of the larger, he gets more credible figures, a mass 20 to 30 times the sun, and a luminosity 10,000 times as great. The latter figure is not alarming, for the star's spectrum shows the characteristics associated with great luminosity, and to a very marked degree. With an inclination of 65 degrees, the mass of the smaller star comes out 24 times the sun's, and that of the large star 21; the radius of the first 120 times the sun's, and of the second 3100 times. The larger star probably radiates almost as much energy into space as the smaller, but, on account of its enormous area, it emits very much less per square mile, so that its calculated temperature is only 1120 degrees K, or 850 degrees, Centigrade, above the ordinary zero. Could we see it close by, and alone, it would appear to shine with a dull red glow; but in comparison with ordinary stars it is practically a dark body. The eclipse is almost grazing—the maximum apparent depth of the outer edge of the smaller star, behind the boundary of the larger, being only one third of the diameter of the former.

The light of the companion thus penetrates only the outermost layers of the big star—the eclipse is by this star's atmosphere, and not by its main body.

Dr. Struve shows that the absorption lines produced by such an atmosphere—taking into account the orbital motions and rotation of the stars—are capable of explaining the peculiar changes in the spectral lines observed during and near the minimum. Dr. Strömgren offers an explanation of the outstanding problem—why the atmosphere cuts off the light of the star behind it almost as if it were a sharp-edged shade-glass, transmitting about half the incident light. To follow all the details of his reasoning would lead us too far; but the main principle is not hard to understand. The upper atmosphere of a star as cool as the companion appears to be should be composed of gas which, judged by our ordinary standards, would be called almost perfectly transparent. The small scattering by the gas-molecules themselves, which makes the sky above us visible, demands a very much greater amount of gas than is in question here. But, when a gas is ionized, the electrons in it get a far more powerful grip on the light waves than the neutral molecules do and produce a sort of haziness. This electron-scattering affects all wavelengths to the same degree, and so is equivalent to a gray haze.



Courtesy *The Astrophysical Journal*

The dots represent measurements of the velocity of the brighter component toward or away from the earth. When above the zero lines the star is moving away from us, when below it approaches us. The two vertical bars near 1930 indicate the first and last contacts of the eclipse

At the star's low temperature there would be very few free electrons indeed in the atmosphere, and it would be very transparent. But, on the side toward the companion (which has a spectrum of Class F2 and is somewhat hotter than the sun) the ultra-violet light from this would fall on the atmosphere and ionize it. The sun's light does much the same for the earth's atmosphere, producing the ionized "Heaviside layer" which reflects radio waves around to the antipodes; but in this case atmosphere and electron-haze alike are too thin to produce perceptible effects in thicknesses of 100 miles or less.

In the great star we have to deal with distances of hundreds of millions of miles and effects which are imperceptible on earth may mount up to be conspicuous. The ultra-violet light of the companion, which ionizes the atmosphere, is absorbed by the processes involved, and so cannot penetrate to a very great depth. If, therefore, we had a thick layer of gas, of uniform density, exposed to such light, the outer portions would contain electrons and be hazy. Deeper in, as the ultra-violet rays were weakened, the haze would thin out, and, beyond the depth to which these rays could reach, the gas would be clear. For a smaller depth than this the total haze-obstruction to visible light would increase with the depth; but for greater depths it would not, for the deeper portions of the gas would be clear.

This very ingenious suggestion solves the main problem: how the layers of gas, of very different thickness and density, through which the light of the companion passes during the eclipse, can exert almost the same effect in weakening the light that gets through them.

Strömgren goes on to work out the more complicated case of a spherical atmosphere growing denser inwardly, and finds, after pages of mathematics, that the haze-layer should have a practically sharp outer boundary, and that the absorption should actually be a little greater for light which has passed at a grazing angle just inside this boundary than for rays which have gone deeper, but less obliquely at the start. The scattering by the gas-molecules or atoms—which is probably not quite negligible for the rays which pass deeper—may balance the effect and give substantially the observed type of light-curve. This analysis, while brilliant, and based on sound physical principles, leaves some minor difficulties. It is hard to see why such an atmosphere as is postulated should not produce some absorption lines of its own, stronger than any that have been observed. Moreover, the amount of ultra-violet light which the smaller star must be assumed to emit is much greater than would be anticipated from its size and "temperature" (estimated in the usual way). There is an increasing quantity of evidence, however, that stars, even down to the sun's temperature, *do* give out more ultra-violet than we had supposed; so this difficulty is not so bad.—*Princeton University Observatory, February 3, 1938.*

Power from Bacteria

Troublesome Pulp Mill Waste Supplies Gas for Power... Swamp Bacteria Do the Work... Fifty Year Old Problem Solved for the Pulp Wood Industry

By M. K. ELWOOD

THE history of research contains many strange chapters on the resourcefulness of science in utilizing the waste materials of industry. Few of these instances, however, are stranger than the story of two research chemists of the pulpwood industry who have put ordinary bacteria to work producing power from the sulfite waste liquors of pulp mills.

Several years ago these two chemists, Dr. A. M. Partansky and Dr. H. K. Benson, of the University of Washington, were approached by officials of the Puget Sound pulpwood industry.

"We use the sulfite process of manufacturing pulp," said the officials. "For every ton of pulp we produce, we have 10 tons of sulfite liquor left over. The liquor can't be used again so we have to throw it away. If we dump it into rivers and lakes, we poison the water. We can't afford to evaporate it. Will you help us find a practical way to dispose of it?"

Here was a challenge which could not be ignored. In their well-equipped laboratory in the University of Washington at Seattle, Drs. Partansky and Benson started to work. Their first task was to learn all that they could about their subject.

The pulpwood industry, they discovered, has been plagued with the waste-disposal problem ever since 1867, when the sulfite process was first patented by an American engineer. This sulfite process is a method of extracting pure pulp from pulpwood by dissolving in acid all the other ingredients in the wood. It is accomplished, briefly, by saturating chips of pulpwood with a strong solution of sulfurous acid, and then steaming the mixture in huge "digesters" for eight or ten hours. This cooking process dissolves the intercellular portions of the wood, leaving only pure cellulose fiber (pulp) when the acid is drained off.

THE acid which is drained off, the two scientists learned, is the waste liquor which must be disposed of. For the United States pulpwood industry as a whole, it amounts to 15,000,000 tons per year.

There are a number of reasons why the liquor can not simply be dumped into rivers and streams, they found. One of the ingredients of the solution is sugar, which forms a natural food for tiny algae (*Sphaerotilus natans*) that are present in all fresh water. As a result of the sudden increase in food occurring when waste liquors are dumped into the water, the algae multiply at an abnormal rate and soon cover the bottoms and surface of the streams with a dark, ill-smelling scum. So thick do they become under extreme conditions that they completely cover the feeding grounds of fish and shellfish, causing a migration of sub-surface life to clearer waters.

Furthermore, the sulfurous acid in the liquid has a harmful effect. Its rate of absorption of oxygen during oxidation is quite rapid, and, in slower streams, sometimes actually deprives the fish of oxygen for respiration; and the sulfur dioxide, which usually forms, has a "rotten-egg" odor unpleasant to human beings. In very small streams where the solution is strong, the acid has a poisonous effect on the vegetation along the banks.

A third harmful constituent of the sulfite waste liquors is a small quantity of cellulose which is carried off in the solution. These cellulose fibers have the property of collecting and precipitating sewage and other refuse which may be in the river—with obvious unpleasant consequences to persons and cities downstream.

To counteract these detrimental effects, the scientists learned, the pulpwood industry has tried many remedies. Experiments have shown that the harmful algae will not grow as rapidly if their sugar supply is sent to them intermittently instead of in a steady flow. As a result of this discovery, pulpwood mills have adopted the practice of storing the waste sulfite liquors in reservoirs, and then releasing it at intervals of 10 to 20 hours. To counteract the sulfurous acids, some mills dilute the waste liquors with immense quantities of water. And to overcome the precipitating effect of the cellulose, technological processes have been developed to remove a higher percentage of the fibers from the liquors.

Despite these many counteractive measures, however, a certain amount of damaging result seems unavoidable. In the Puget Sound area, for example, despite every precaution taken by the pulp-paper manufacturers, the sulfite liquors have been slowly poisoning fish and oyster feeding grounds. Repeated lawsuits have finally forced the mills to divert their waste liquors into a deserted area known as Dry Lake.

After learning these facts about the sulfite process, the two research men next turned their attention to the history of the many attempts to convert the waste liquors into some useful product —a feat which has been the objective of hundreds of scientists for half a century.

THE majority of experiments directed toward this end, they learned, have been chiefly concerned with utilizing the liquors to manufacture wood-alcohol. In the course of five decades, several distilling processes have been developed, some of which will produce as much as 15 gallons of alcohol from the liquors of a ton of pulp. The demand is so limited for the inferior alcohol produced, however, that few pulp plants have attempted this method of utilization. The conclusion has been generally accepted that this method will become practical for the entire industry only when some tremendous new market is opened for alcohol—as might be the case if alcohol ever replaces gasoline as a motor fuel.

Other experiments in utilizing the liquors have been tried in the field of agriculture. A neutralized solution of sulfite liquor mixed with molasses, it has been found, makes a fairly satisfactory food for cattle. A similar solution, mixed with nitrogen and phosphates, makes an excellent fertilizer for soil poor in humus. Unfortunately, however, both byproducts are too expensive to compete with other commercial cattle fodders and fertilizers.

In the field of medicine, sulfite liquors have been found useful in treating hoof and mouth disease and in the treatment of pulmonary diseases. However, here again the recovery process is too costly and the market too limited to answer the question for the pulpwood industry as a whole. Similarly, attempts to utilise

the liquors as a tanning agent, as a preservative, and in making of dyes, have proved impractical in all save a few exceptional cases.

Recently a method has been developed in Europe for making yeast from the sugars contained in the solution, and one such recovery plant has already been built on this continent—at Liverpool, Nova Scotia. This method, while economically practicable, does not completely solve the disposal problem, however, as the bulk of the liquor is not utilized in the process and must still be cast aside.

The nearest to a successful solution that the Washington scientists were able to uncover was a European process of using the liquors as a binder for briquetting powdered fuel (coal, peat, sawdust), for making foundry sand-cores, and for binding road dusts.

It was this latter use which interested them most. Many foreign countries—especially in Scandinavia—have surfaced their roads with concentrated sulfite liquors, and tests have shown that this binder will remain hard and dustless as long as will ordinary road oils. Since there are in the United States approximately 1,413,800 miles of unimproved roads, this means of utilization seemed to offer the pulp industry a wide opportunity.

Photographs courtesy U. S. Bureau of Fisheries

Paper pulp mills use great quantities of water in producing pulp by the sulfite process and discharge sulfite liquors into nearby streams. One of the results of this practice is the destruction of fish and other aquatic life by the contaminated water

The two chemists began experimenting. They first tried the liquor on the cinder athletic track at the University of Washington, where they found it an extremely effective binder. Then, through the co-operation of a Shelton pulp and paper company, they managed to persuade the highway engineers of Mason County, Washington, to try the liquors on a 13-mile stretch of road.

It was at this point in their work that the two chemists had an ingenious idea.

Many years previously it had been definitely proved that the formation of marsh gas (methane) was caused by the action of tiny anerobic (airless) bacteria which fermented the cellulose contained in decaying swamp vegetation. If this was so, reasoned the research men, why couldn't the same bacteria be used to generate methane from the organic material in waste sulfite liquors? The methane produced could then be burned to generate electric power! It was an attractive idea, they decided, and would be well worth investigating.

The two scientists procured a large number of gallon jars. Into each jar they poured 850 cubic centimeters—about one and one-half pints—of neutralized sulfite waste liquor. To this they added two kilograms—about four pounds—of ordinary mud taken from swamplands where anerobic bacteria were active. The remainder of each jar, except for an air space of about 100 cubic centimeters, was filled with water, and the jar was placed in a chamber kept heated to 36 degrees, Centigrade (96.8 degrees, Fahrenheit).

Day after day, through tubes running from each jar, the scientists measured the amount of gas given off by the mixture. At the end of 340 days—almost a year after the start of the experiment—they added up the total quantity of gas which had been given off.

The average amount of gas which had been produced from each jar, they found, exceeded 18,000 cubic centimeters—more than 20 times the volume of the original sulfite liquor. Seventy-eight percent of this gas was methane, while the remainder consisted of carbon dioxide and a small quantity of hydrogen. Most important of all, they found the heating value of the gases produced to total 134,900 calories per jar—which, translated into large-scale terms, meant that from the liquors of every ton of pulp it would be possible to generate gases with a heating equivalent of nearly 400 pounds of coal! The experiment was decidedly a success! At the generating rate of the first experiment, the total heating value of the gases which can be recovered in the United States will be equal to more than 300,000 tons of coal per year!

And thus was begun the development of a process for putting the tiny bacteria to work. Since that first experiment, a great deal of additional work has been done. A method of hastening the fermentation by precipitating the lignin in the solution has been discovered. Gas engines capable of efficiently utilizing the fuel have been perfected. Today the process has graduated from the laboratory stage and is now ready for commercial use.

The first fermentation plants are now being planned to utilize the waste liquors in combination with sewage wastes from nearby municipalities (sewage wastes re-act to the Partansky-Benson process in much the same way as the pulp-mill wastes). Later on, disposal plants will probably be built for handling sulfite waste liquors alone.

And although other attempts to utilize the sulfite waste liquors have not been entirely discontinued, it is almost certain that the Partansky-Benson process will be adopted by most of the pulpwood industry. Because the recovered methane power can be used right in the pulpwood plants, eliminating the need of developing markets for a new product, the majority of the 181 pulpwood establishments in the United States will probably prefer this method of disposal. It is the perfect answer to their question: "How can we utilize our waste liquors?"

FROM STEEL

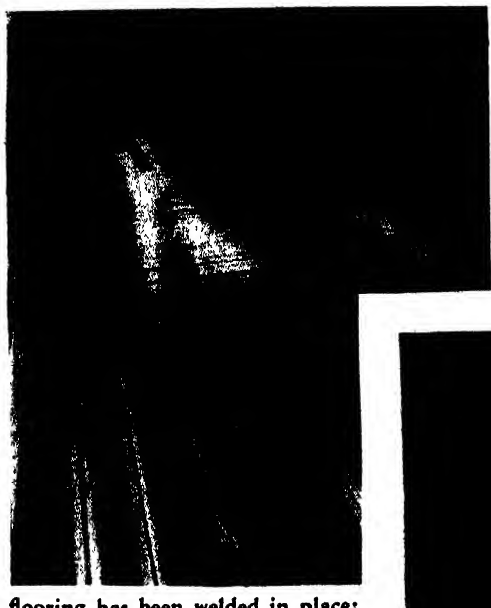
1 Light-weight equipment of tremendous strength, capable of high sus-
ained speeds with safety, is the modern
lemand of the railroads. Streamliners,
heathed in shining metal, are the
nanufacturer's answer. *Above:* Coils of
trip steel are fed through a draw-
ench, to be formed for use in the con-
truction of a new streamlined railcar

2 Alloy used in the Reading streamliner is stainless steel, cold-rolled to increase strength and elasticity. *Circle:* With a "Shotweld" machine this expert controls perfectly each weld on a side frame in the first step of assembly. See also illustration on front cover

Photographs courtesy Edward G. Budd Manufacturing Company

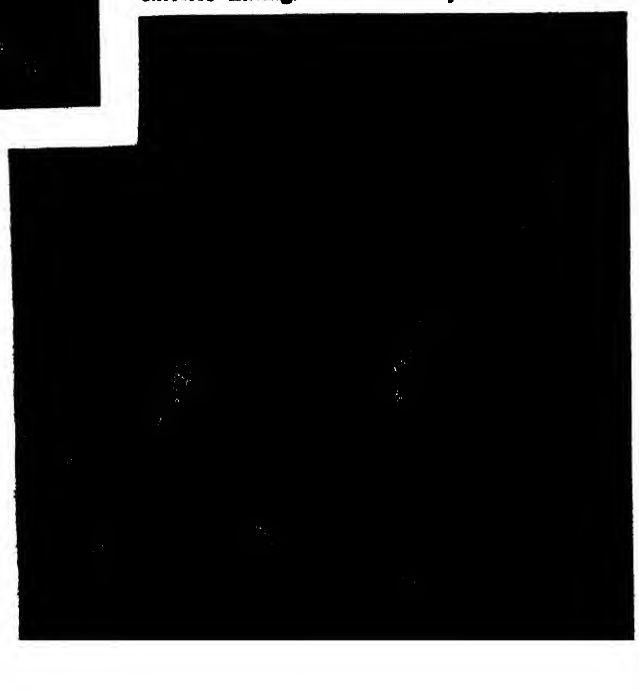
3 While the side frames of the car are being assembled on one line, the roof is started on another and parallel line. The roof structure will join the side frames after the floor (Photo 5) has been installed. *Right:* Welder putting the final touches on the roof just before it goes into the basic structure of the streamliner

4 Through the utilization of welding and of stainless steel alloys which have approximately four times the tensile strength of ordinary steel, it is now possible to produce railcars in which the weight has been reduced to almost half that of former standard equipment. *Above:* Substructure of a railcar, with center sill and cross members in place, ready for assembly of side walls and floor



5 *Above, center:* Part of the first flooring has been welded in place; it is made of corrugated stainless steel similar to that of the roof. The grooves of this first flooring will be filled with a plastic deadener over which will be placed a layer of cork before the floor covering goes on. This construction assists in sound- and thermal-insulation

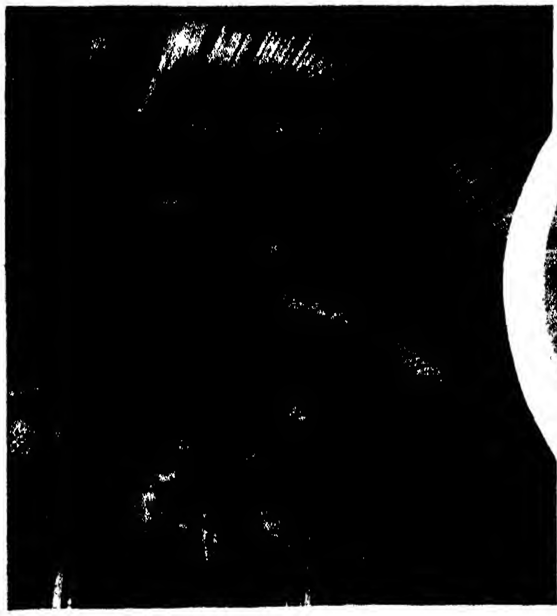
6 Smooth, safe travel in this streamliner is assured by electric pneumatic brakes, side sway eliminators, other developments. *Below:* A workman assembling a truck on a third line. At the same time, other workers are installing exterior flutings and window panels of the car



TO STREAMLINER

By A. P. PECK

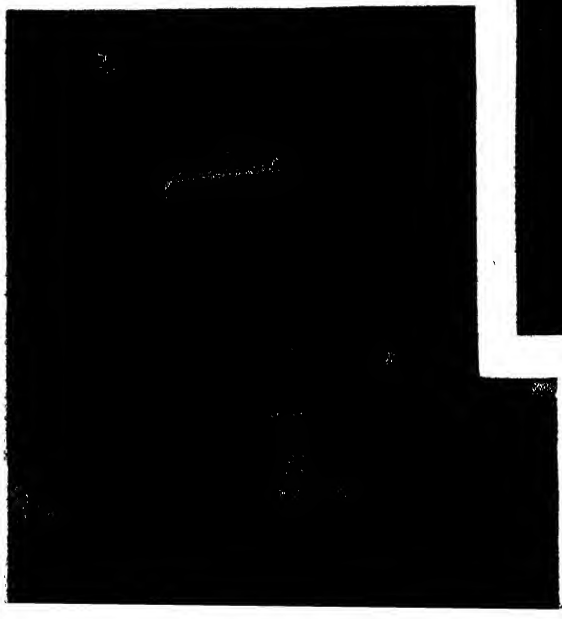
9 The fluted panels on the outside of the car are installed individually so that they may be removed without disturbing the rest of the structure. Following this, the car undergoes a rain test, during which a spray of water under 80 pounds pressure is directed at every joint and seam; if leakage is detected, the defect is remedied immediately



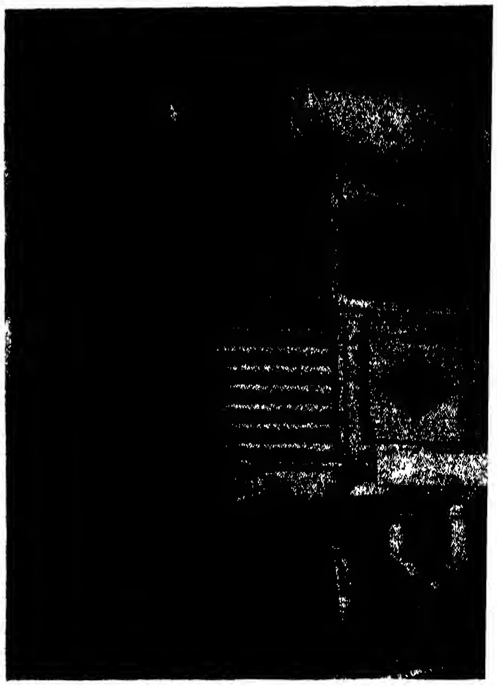
7 Installing the interior trim in the railcar. The thin strips which have been welded to the under side of the roof structure will hold in place the sound deadening and the heat-and-cold insulation material. In one of the tests which these cars undergo during construction, weights are distributed throughout the car to simulate maximum load during operation. An engineer then checks the structure for deflections

8 The fin-type radiators have been put in place near the floor and insulation has been installed in the side walls. The baggage racks (not shown) have been hung and above them has been placed the heavy roof insulation that protects passengers from extreme temperature changes while traveling

10 How one of the cars of the streamliner looks from underneath. The trucks have been installed and all of the piping insulated to reduce vibration and temperature losses. Final adjustments on the air-conditioning system are made before the car leaves the shop



11 The trimmers and decorators have completed their tasks; the car is ready for the road. Individual chairs revolve and recline for maximum convenience and comfort. The streamliner is complete in every detail—dressing rooms, smoking compartments, lounge, diner, and an observation car



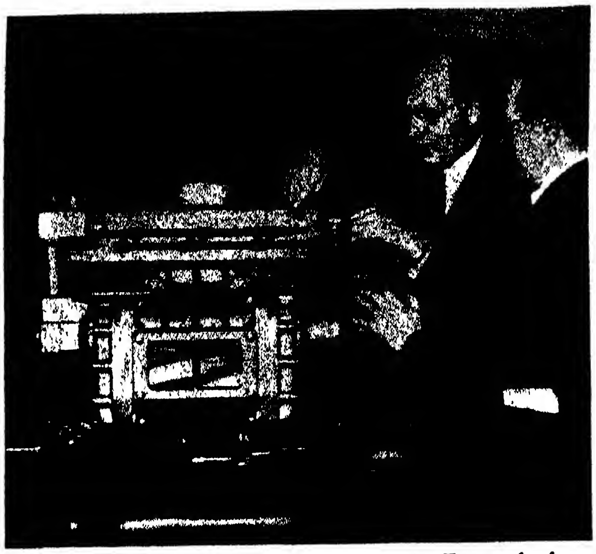
12 The factory's work is done. The train is ready for service on the Philadelphia-New York run, where it is now providing travel comfort unthought of by railroad men only a few short years ago. To metallurgy and welding, working hand in hand, must be given the major portion of the credit for the development of these newest, fastest, safest monarchs of the shining steel tracks of the railroads ■

The Diesel Broadens

"Packaged Power" for Many Uses . . . A Complete Power Plant in One Unit . . . How Will Increased Fuel Demand Affect the Market Price?

About the time this article reaches its readers, it may well be that the owner of a small factory in the deep South, far from a convenient source of cheap electric power, will be unpacking a strong, but compact, case with something of the anticipation of a small boy on Christmas morning. Or that the owner of a large farm somewhere in the northern prairie states will be setting up the contents of a similar crate, rejoicing that for the first time he will be able economically to milk by machinery and to make a dozen different applications of minor power which he knows will lighten his burden and fatten his pocketbook.

These men will have purchased "packaged power" offered—to a degree not hitherto available—through the fundamental developments which have been made in the Diesel engine field by General Motors Corporation. The significance of these developments has thus far only been hinted at. They would seem to mean—given the maintenance of prices for Diesel fuel at a figure within reason—that the advantages of the oil-burning engine may be extended into a variety of industrial categories not even dreamed of a few months ago. It is perhaps not too much to say that out of the fascinating, extraordinarily sound-proofed, modernistic laboratory in a hardwood grove near Detroit, which is the real seat of the whole undertaking, an effect of major importance on American economic and social life may come.



Charles F. Kettering (left) and R. K. Evans, both active in the General Motors' Diesel development, inspect one of the new medium-size power plants that have been designed for a wide variety of uses

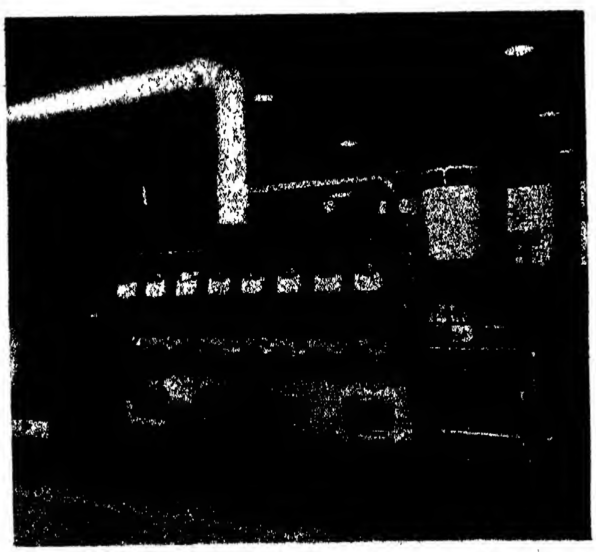
Taking heart from the immense proved success of the large Diesel-electric applications which power so many of the streamlined trains that have been making railroad history in the last three or four years, the great automotive producer has plainly decided to throw the full weight of its resources and its technical knowledge to a very much broadened field of the whole Diesel undertaking.

The restless, inquisitive genius of Charles F. Kettering, vice-president in charge of research, and of a corps of younger, but no less enthusiastic, engineers, have been making exhaustive study and experiment in the Diesel field for at least a decade. The surface story of what they have accomplished in the design of two-cycle Diesels for railroad use is already familiar; some of the significant facts developed by the operation of these larger Diesel electric units are not so well known. For example, the *Super Chief* of the Santa Fe Railroad — Diesel-powered — has never yet been late at any terminal or intermediate stop. No comparable record has ever been made by a steam-drawn train. Last winter in the Continental Divide the Union Pacific had its usual quota of snow. When a particularly bad storm blocked one of the high passes, a steam train was sent in to clear the track. The train got stuck and had to be pulled out tail first. Then a Diesel-powered train was sent in; it hit the snow at 80 miles an hour and came out on the other side at 50 miles an hour. Thinking the pass was clear, the steam train was sent in again. Again it was stuck and had to be dug out; it was left to the Diesel to do the pass clearing.

H. L. Hamilton, president of the Electro-Motive Corporation, a G-M subsidiary, is authority for the statement—and it is backed by railroad operators—that in switching-engine service alone, if the Class 1 railroads were to put into service 3000 Diesel locomotives, this number, about 25 percent of the present locomotive inventory, would cover about 50 percent of the present switching hours and effect a saving of 52,000,000 dollars annually in operating expenses. This saving would be sufficient to liquidate the investment in Diesel locomotives in five years and would allow the retirement of not less than 5000 old and obsolete steamers.

If this prime mover was so eminently an answer to a railroad's prayer, the forward-looking minds in General Motors thought, why not extend its benefits downward so that the small man in almost any field, where more power than that supplied by a single "home-lighting" unit would be useful, could share in oil-burning economies?

This is precisely what has been done in the set-up of the Diesel engine division of the corporation. It involves the new factory at Detroit with its satel-



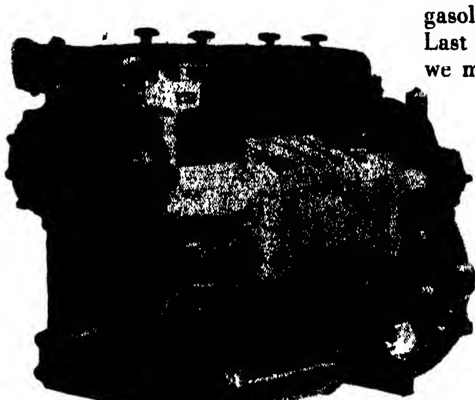
A 16-cylinder Diesel and a 1000-kilowatt generator furnish power for the Diesel development laboratory

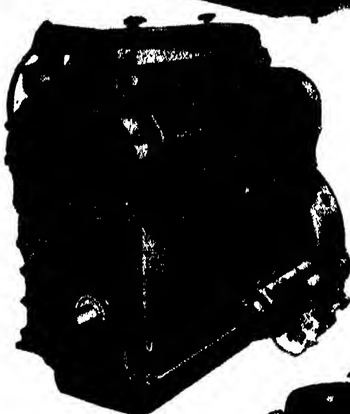
ITS FIELD

By REGINALD M. CLEVELAND

lite (more important than the planet) the laboratory; the taking over and development of the former Winton Engine Manufacturing Corporation of Cleveland; and the expansion, just now reaching completion, of the locomotive shops of the Electro-Motive Corporation at La Grange, Illinois.

At La Grange, the railroad and large marine units, such as those for the Navy, will be produced. At Detroit will be built the little fellows running down from six to one cylinder and from 160 to 22 horsepower. At Cleveland will be manufactured a full line of medium-size engines, ranging from 200 to 400 horsepower. Here too will be produced the "packaged-power" units which consist of small size Diesel engines and generators, in either stationary or portable models, which can be quickly set up, complete with base, wiring, radiator, and fan, to power small industrial operations, hospitals, theaters, irrigation projects, tractors, pumps, hoists, parking lots, and a score of other enterprises.



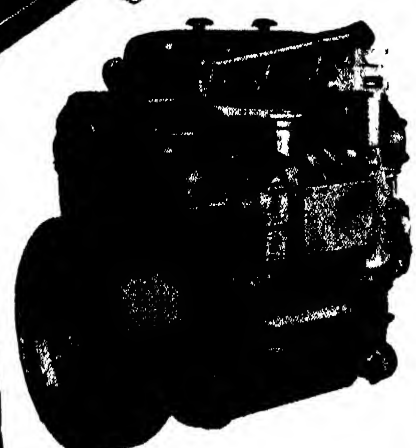


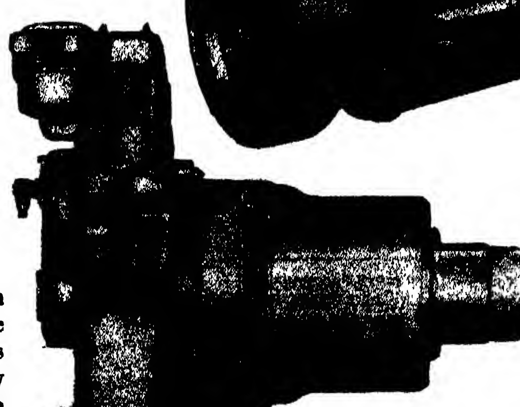
NATURALLY, the smaller sizes will be used in extending Diesel truck and motorboat applications. While officials of the corporation say very definitely that no application to passenger car or aircraft use is at present in sight, and refuse even to confirm a guess as to when such development may be expected, it would be foolish to suppose that out of the Detroit laboratory will not come efforts in these fields with their obvious advantages of economy and safety.

In outlining the problem that General Motors has attacked, "Boss Kett" as usual comes down to fundamentals.

"There is no trouble," he says, "about getting engines to work on special fuels today, but we said we didn't want any fuel specifications at all; we want to operate on any standard furnace oil available in the community in which we live. You shouldn't have any special lubricating oils; you should be able to run on any of the standard SAE 30 or 40 oils available in the community in which you operate.

"These engines shouldn't be bigger than the gasoline engines; they shouldn't weigh any more. The smaller engines weigh more than gasoline engines for a good reason; the designers elected to use the standard parts from the big engines for the smaller engines, but still the engines are much smaller and lighter than any competitive engine on the market today.





Top to bottom: **Two-cycle Diesels of six, four, three, and one cylinder types. The lower one, a single cylinder model furnishing 22 horsepower, is complete with an electric generator in a "packaged-power" unit**

"There is some correlation between gasoline engines and Diesel engines. Last year, at 50 horsepower per vehicle, we made more than 200,000,000 horsepower of gasoline engines. We made about 1,000,000 horsepower of Diesel engines last year. They were made by 25 or 30 manufacturers. Now, the Diesel manufacturers aren't to be criticized, because they have had to take the job as they could. This is the first attempt we have ever made to try to design a line of engines all the way through, tool-up for it, on the same basis and with the same technique the gasoline engineers use. We have built something like 40,000,000 automobiles in this country, and out of that much experience we have learned to do a pretty good job. We have tried to take that knowledge and apply it to a similar operation.

"FOR the first 20 years—the Diesel engine is about 40 years old, about the same age as the gasoline engine—they had to make Diesel engines like steam engines because they put them in where steam engines came out. The next 20 years they have been trying to make them like gasoline engines. I think this is the first serious attempt that has ever been made to make them like Diesel engines.

"We are introducing a new type of power here; which is a remarkable thing. There is nothing like it in the world. It is very much lighter than any corresponding type of machinery. We have enough faith in it to build these plants and these laboratories."

The engines which have resulted from this formula are compact, smooth-running, and remarkably vibrationless even at 1800 to 2000 revolutions per minute. In the astounding laboratory where the testing is done there is a strange degree of silence. The building was purposely erected on marshy ground, on steel and concrete piles running down about 75 feet. Each test bed in the eight bays opening on a common corridor is also mounted on an independent system of piles, insulating it from the rest of the structure.

Although when the writer was last there Diesel engines were generating at least 10,000 horsepower of energy—

Production and experimental models of Diesel fuel injectors are kept under constant test in machines such as this. The plungers, building up injection pressures of 50,000 pounds, are forced up and down 3,000,000 times a day as engineers check for defects, make plans to remedy them

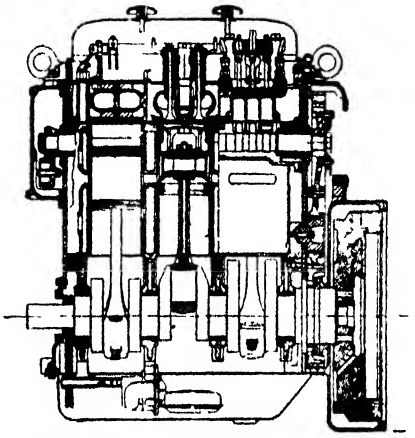
and all this horsepower is used in the form of electricity in the laboratory and adjacent plant—it was quiet enough within the building to talk without marked effort and outside the building there was only a low, droning hum.

The G-M two-cycle Diesels are notable both for compactness and for the interchangeability of parts. Thus, all of the accessories such as exhausts, blowers, auxiliary drives, and so on, can be removed from one side of the engine by the veriest tyro mechanic and attached to the other side. It is not difficult to realize the importance of this feature for boat use or in any place involving cramped quarters. Moreover, the simplest sort of an adjustment makes it possible to reverse the direction of rotation.

APPLICATION of precision standards has been carried out, in the new Detroit plant, to a degree never before applied to mass production—early factory schedules call for 50 engines a day. Some idea of the precision manufacturing involved may be had from the tolerances required in the most exacting parts. For example, maximum clearance between the bore or barrel of the fuel injector and the plunger which moves within it must not exceed 50 millionths of an inch. Maximum clearance at the tip of the injector between the needle valve and the bore within which it moves must be less than one ten-thousandth. The average run of limits of all other parts of the injector assembly is of the order of one ten-thousandth.

These delicate parts are measured by that remarkable instrument, the Electrolimit gauge, which is accurate to the millionth part of an inch, but gives an exact reading on a large calibrated scale. As you watch this scale, you find that one ten-thousandth of an inch, a measurement too small to comprehend, is shown on a scale larger than that of one of the instruments on the dashboard of your automobile.

The hole in the injector nozzle—a very vital consideration in the proper operation of a compression-ignition engine—varies, according to engine size, between six thousandths and fourteen thousandths of an inch in diameter. Drilling is done by the use of special machines, designed at the plant, in which the drill rotates at extremely high speeds by the use of a tiny, air-operated



Longitudinal cross-section of one of the new three-cylinder Diesels

turbine. So sensitive is the drill itself that mechanical means will not suffice to feed it into the work. The spindle floats and is eased into the work by the operator's sensitive fingers as the drill rotates. Each injector is tested on one machine which determines its seal under pressure of 5000 pounds to the square inch and then on another which "pops" the nozzle to insure clear passages.

Dozens of specialized machines make possible the application of watch-making precision to a production operation.

At the present cost of Diesel fuel, it is estimated that the small industrialist and the big farmer, removed from giant sources of power supply like Muscle Shoals or Boulder Dam, can produce his own electricity by means of the new Diesel "packaged power" at a cost not to exceed two cents a kilowatt hour. It is obvious that very broad implications as to decentralization of industry and as to independence of public utility domination, now so liberally castigated in high places, are implicit in such a situation.

There is every reason to believe that a new page has been turned in that story of progress which has marked the patient years since the first application of compression-ignition to power production by the late Rudolph Diesel.

THE fly in the ointment is, of course, the bugaboo of rising Diesel fuel costs, both by reason of price loading by producers and tax pyramiding by legislators. Many oil experts hold, however, that should a demand arrive for Diesel fuel which would supplant a considerable proportion of the gasoline demand, there is nothing in the economics of refining which would justify an untoward rise in the cost of Diesel and domestic oils. It would seem to behoove those who have a real interest in the continued march of technological progress here indicated to keep a careful eye upon this aspect of the situation, and to see to it that the tax gatherer does not unduly hinder a development which is in the broad public interest.

Boring the aluminum blower housing of a Diesel. In the finished engine the blower is a scavenger, forcing burned gases out of the cylinders after each power stroke

The 'Fourth Transcontinental'

THERE was a time not so long ago when a single pair of wires would carry all the transcontinental telephone traffic there was, and even then, time hung a bit heavy on its cross-arms. But since that first year the wires have carried a rapidly growing stream of traffic, and one by one, new routes have been carved across the country, new wires added.

Only part of this traffic has been telephone calls. The business of east and west has become so closely interrelated that the old Boston house of Smith & Company must have a branch office in San Francisco to handle its business out there, while the great Los Angeles firm of Jones Brothers must have a sales office in New York—with private telegraph or teletype lines between the two offices. Newspapers on either side of the Rockies exchange news—and pictures—daily, by wire. Finally, the broadcasting stations of the country are welded into great chains by means of wires.

Until recently, three routes across the country were able to handle comfortably the 400 or so daily telephone conversations, the coast-to-coast broadcasts, the telephotographs and the steady stream from hundreds of telegraph keys and teletypes. But studying the growth of these services, engineers realized that before long, more channels must be provided. The result was that the Long Lines department of the American Telephone and Telegraph Company set to work and built the "Fourth Transcontinental," an express telephone highway of large capacity, designed to take over a substantial share of the increasing long-haul traffic. Following the flight of the crow from Oklahoma City to Los Angeles, it cuts square across some of the toughest tracts in the country. Along one section between Amarillo and Albuquerque, some five tons of dynamite were used to blast holes for the telephone poles. All along the route are great furrows in the earth that are now "dry washes," now the beds of seething floods. All of these had to be spanned by some suspension device. Over and over again, the rough terrain presented some problem that had to be solved with an eye on the future and to what changing conditions would do to today's handiwork.

"X" marks the spot for the next pole. Whether there be mud or sand, or rock that must be blasted out, that spot is where the pole must go

The significant feature of the new line is the equipment now being installed at its terminals—"carrier current" apparatus whereby new voice channels can be superimposed on each pair of wires, at high frequencies, ranging from 36,000 to 140,000 cycles. By combining this system with existing methods, it will be possible for *16 pairs of subscribers* to carry on, simultaneously over a single pair of wires, 16 conversations as neatly and effectively separated from each other as the layers of a club sandwich.

With the installation of the carrier system, more "repeater" stations are being added at numerous points. These repeaters, consisting of vacuum-tube amplifiers that re-energize the voice in its travel over the wires, are usually spaced from 100 to 300 miles apart. Along the carrier channels of the "Fourth Transcontinental" between Oklahoma City and Whitewater, California, a distance of about 1200 miles, there will be 16 or 18 repeater stations—an average spacing of 65 to 75 miles.

Because of the high frequencies to be used, the cross-arms on this line are placed three feet apart, instead of the usual two, as a means of minimizing the "cross-talk" between adjacent wires. It is also necessary to have frequent "transposition" of each pair of wires—the wires crossing each other, in some cases, at every other pole.

ANOTHER requisite of the new system is that poles must be spaced evenly, or very nearly so—not always easy in such terrain—and the sag of the two wires of each pair must be uniform. To produce the desired accuracy, there must be careful adjustment of the wires. In the principal method used, each wire of the pair is plucked in such a way as to cause it to vibrate. The period of oscillation of each wire is compared with that of the other wire of the pair. If these periods are found to be alike, the wires have the same sag.

The new channels on the "Fourth Transcontinental," which enters the Bell System cable network at Oklahoma, will bring the total number of direct circuits from New York to San Francisco and Los Angeles up to 20, while from Chicago there will be nearly 30 direct circuits to West Coast cities.

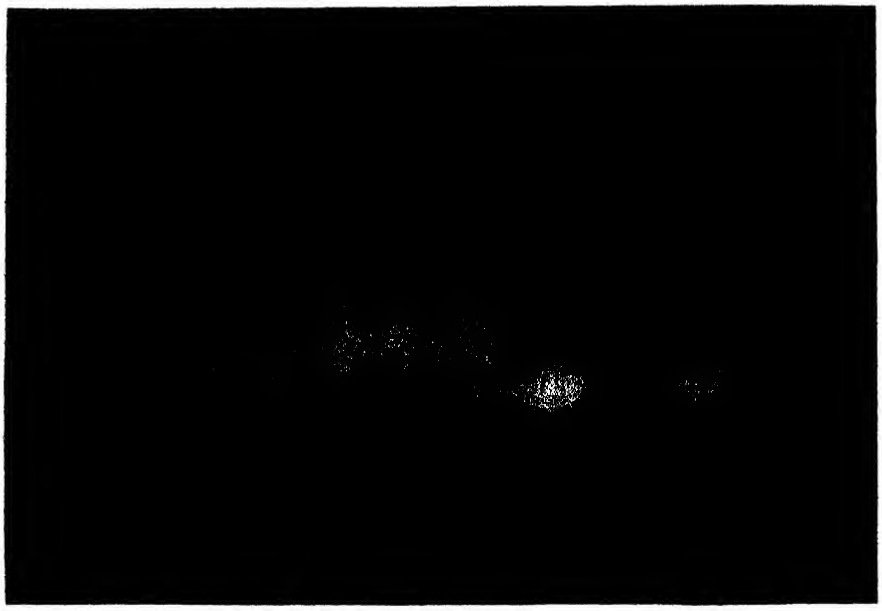
Since that first tiny filament crept across the Sierras in 1915 there have been notable developments in transcontinental telephony. Some of them interest the scientist, some of them interest the historian. One of them interests everybody, and that is the price of long-distance telephony. In 1915 a three-minute talk between New York and San Francisco cost $20.70. Today, for 30 cents more, one can talk across the Atlantic, while a "station-to-station" talk from New York to San Francisco now costs only $6.50. With this downward movement in cost has come an equally notable upward movement in the quality of transcontinental circuits.

Wires over the cross-arms are pulled taut. On the poles, linemen check the sag of each pair to insure uniformity

NORTHERN LIGHTS

Why the Scientist Studies the Aurora: Research that Is Bound up Closely with a Number of Other Phenomena in the Upper Regions of the Atmosphere

By A. S. EVE, C.B.E., F.R.S.
Emeritus Professor of Physics, McGill University, Montreal



Auroral streamers, photographed at Oslo, Norway, by Prof. Carl Störmer. In the annals of auroral research Professor Störmer's name is extremely prominent

THE appearance of the northern lights has been frequently described, and in any case words are quite inadequate to describe its beauty. The three main forms of display are the arc or arch, the curtains, and the long streamers. The color is commonly greenish white or greenish yellow, sometimes with an admixture of red or violet. The first appearance of the aurora is sometimes a bright quiescent arch with its peak a few degrees west of due north. This may suddenly be followed with a host of streamers, like searchlights, but changing, flickering, and dancing. At other times the display begins with nearly vertical curtains of light, the folds of which keep changing in form. The drapery is usually to the north, spreading from east to westward, but sometimes it appears quite overhead. Even as far south as the state of New York the curtain may sometimes be seen south of the zenith.

The altitudes of these displays have been skilfully measured in Norway by Störmer, with a number of observers connected by telephone, who took photographs at the same instant from different places (Figure 1) at a measured number of miles apart. A simple calculation determines the altitude of the aurora. About 60 miles is the most common result; that is, 60 miles from the surface of the earth, not from the observer. Sometimes the tops of the streamers may be 250 miles above the earth, and I believe that the lowest determination is an altitude of 40 miles. The record height for the top of a streamer is 1000 kilometers, more than 600 miles. Similar measurements were made in Canada by Sir John McLennan and others, and the results there were in excellent agreement with the earlier determinations in Norway.

The spectrum of the aurora has been photographed, and most of the lines, or bands rather, are found to be due to nitrogen, which is the major constituent of the atmosphere (about four fifths) here on the earth, and remains the chief constituent at great elevations. The spectrum of the aurora also includes the famous green line which Sir John McLennan investigated so ably and proved to be due to oxygen in an enhanced or unusually excited state. He and his co-workers actually produced the green line in his laboratory at Toronto by suitable stimulation of oxygen with helium, neon, or argon also present. About 1 percent of the air at ground-level is argon. All the other rare gases are present in much minuter quantities: neon, krypton, xenon, radon. Hydrogen is so light, and the molecular velocity in consequence so large, that the hydrogen overcomes gravity and passes out of the atmosphere.

Some of these gases, notably neon, the ingenious Claude has shown us how to collect, to place in tubes at low pressure, and to ionize with high voltage, so that every city is bespangled with artificial auroras, and decorated with an extraordinary variety of colored signs and vivid advertisements. It may well be that some of the rare gases also play their part in the occasional rich coloring of the genuine northern lights, and Sir John McLennan believed that at high altitudes there is more helium than oxygen! On the other hand Kaplan puts forward evidence that enhanced nitrogen can also excite the green line in oxygen.

EVERYONE today is familiar with a magnetic field, particularly as everyone has lived all his life in a feeble field of that character due to our great magnet—the earth. It is not suggested that we know exactly what magnetism is, but then that is true of everything else. If you shoot electrons at right angles to a uniform magnetic field, the electrons will go around in circles—exact circles. The stronger the field and the slower the electrons, the smaller will be the circles, and the converse is true. The mathematical, electrical, and mechanical principles are simple and certain. If, on the other hand, electrons are projected obliquely to a magnetic field, then the electrons will each one describe a helix or a path with the shape of a corkscrew.

If the electrons are shot earthward from the sun, they will travel through space and become entrapped by the magnetic field of the earth. They will spiral around the lines of force until they meet the upper atmosphere in the regions surrounding either the north or south magnetic poles. The speed of such electrons may be sufficient by their collisions to ionize the molecules; that is, to knock other electrons from them, thus leaving positively charged molecules, or ions. The recombination of electrons with positive ions is attended with radiation,

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as has been amply proved in laboratory experiments. It is generally believed that electrons spiraling around in one direction arrive near the north magnetic pole and give rise by ionization to the *aurora borealis*; while similar electrons spiraling around the lines of magnetic force in the other sense proceed toward the south magnetic pole and occasion the *aurora australis*. This result is well confirmed by experiment. It is not easy to ascertain the extent to which auroras occur together at the same time in both arctic and antarctic regions. There are some theoretical reasons for expecting such coincidence, and some of the major displays such as that of February 4, 1872, have been seen in both northern and southern latitudes.

There are some authorities who declare that light, charged particles, such as electrons, would mutually repel one another on their long journey from the sun, so that they would be scattered far afield, and in that case there should be no auroras at all! Prof. S. Chapman states that there are positive, negative, and neutral particles all coming from the sun. There is also quite a wide choice of possible projectiles—electrons, positrons, protons, neutrons, deutrons, alpha particles, and cosmic rays, besides photons. Therefore it is not wise to be too didactic as to the nature of the bombardment that arrives at the earth's surface, but it is right to insist that only electrically charged particles will show so marked a tendency to proceed toward the two main magnetic poles of the earth.

It may very well be asked why it is claimed that the projectiles come from the sun. The answer is that auroras, sunspots, and magnetic storms all follow, over a long series of years, the same periodic variation of increase and decrease in number and intensity. This is the well-known 11-year cycle. In recent years the variation of the effective frequency required for radio signals across the Atlantic has been found to follow the same cycle.

TODAY there are eight different ways of obtaining information about the nature and properties of the upper air (Figure 2).

Pilot balloons filled with hydrogen can carry up small, light, ingenious recording devices. If the balloon is recovered on its return to earth, there are records of elevation, temperature, and humidity. Such balloons may also be followed with a transit instrument, or theodolite, so that the wind velocity at different levels may be deduced. The greatest elevation attained by a balloon, without recorders, was 23½ miles, at Padua. One of Regener's balloons has ascended 17½ miles and been recovered with its recorders.

In recent years attempts have been made to explore the stratosphere in balloons. The intrepid Piccard constructed a gondola sufficiently strong not to explode, and was himself carried inside it upward by a balloon. The ascent is easy, the place and nature of arrival on the earth are largely fortuitous. He reached an altitude of 10 miles and obtained valuable results on the cosmic rays, which at that height are about 100 times as intense as on the earth's surface. The Soviet gondola crashed to disaster after attaining an altitude of 12 miles. The greatest height so far attained is 13½ miles, achieved by Anderson and Stevens in the United States.

A new method of exploration has been devised by Tuve and others, members of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. A searchlight beam is directed upward to a height of 17 to 40 miles, and the intensity of the light is periodically modulated, or varied, at the source. A large concave mirror collects the scattered light from the upper part of the beam and brings it to a focus on a photocell connected to an amplifier, which is synchronised with the modulation of the searchlight. This apparatus may well give some information on the nature of the molecules in those very regions on which we are least informed, above the range of pilot balloons and below the auroral and ozone layers.

Ozone is produced from oxygen by radiations of a suitable frequency or by electrical discharges. Much of the ultra-violet light from the sun is absorbed or stopped in the ozonosphere about 20 to 40 miles above the earth. The presence of the ozone is revealed by absorption bands in the spectrum of the sun. When the sun is high it passes almost vertically through the ozone layer. When the sun is setting its rays have to pass horizontally through a much greater thickness. Measurements of the intensities of the absorption lines due to ozone, lead to an estimate of the height of the ozone region as being about 25 miles, and therefore lower than the northern lights.

THE barometric disturbance due to the great Krakatoa volcanic explosion traveled four times around the earth, and the actual noise of it was heard 3000 miles away. The sound of big guns or of heavy explosions passes upward into the cool and rarefied air and is then refracted or bent back again to the earth, so that sometimes, like short-wave radio, it cannot be heard or detected at intermediate distances. Newton stood in the gateway of Trinity College, Cambridge, and heard the guns of a naval action between the Dutch and the English. He foretold a British victory, because the noise of battle became gradually fainter as the victors pursued the Dutch. The fact that sounds are bent back again to the earth necessitates a warmer layer above the cold. It seems that with increasing altitude the temperature may gradually decrease down to many degrees below zero, Fahrenheit, but at a height of 30 miles there is an increase up to 80 degrees, Fahrenheit, and the heat to maintain this may be connected with the formation of ozone from oxygen by the sun's ultra-violet light.

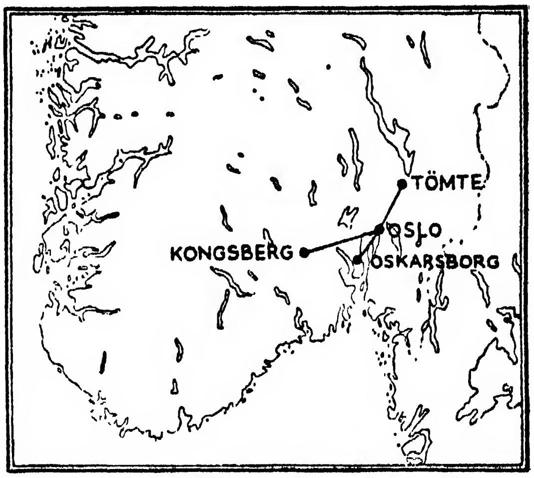


Figure 1: Störmer's network of observing stations, linked together by a telephone network

The most important method of throwing light on the nature of the upper regions of the air is by projecting radio waves directly upward, for it is found that with suitable frequencies they will be reflected back to the earth. It will be recalled how puzzling it was, in the early days of wireless, to account for the fact that the electro-magnetic waves, expected to move in a straight line like light, could travel from Ireland to Newfoundland. Today wireless waves, carrying speech, music, or Morse, can be sent completely around the world, so that a man can speak to himself and hear it a fraction of a second later, using waves which have circumnavigated the globe, changing local time in the most remarkable way as they traveled. During a part of the journey it must have been yesterday, or tomorrow, although on return it was the same day and perhaps about a seventh of a second since they started. It was surmised both by Kennelly and by Heaviside, independently, that the possibility of successful long-range wireless signals depended upon reflection or refraction by an electrified or ionized region at a considerable height above the earth. The proof of the existence of such a conducting region was given by Appleton, who also showed that there is another higher region also capable of reflecting radio waves back to the earth.

The lower or E region is at about 100

kilometers from the earth, and it is also called the Kennelly-Heaviside region. The upper or F region is two or three times as high and bears the name of Appleton. It is possible to send a brief signal of suitable frequency which will be reflected back from both the E and F regions, so that both signals may be recorded on a suitable photographic plate by means of the cathode-ray oscillograph. It is possible to measure the very short period of time between the initial and return signals, and as the velocity of such waves is about 186,000 miles a second, it is easy to deduce the height of the reflecting region. For example, if the interval is one thousandth of a second, the reflecting layer would be about 93 miles above the earth. Experiments carried out by Henderson and others, during a total eclipse of the sun in Canada, proved that the E region is made conducting, or is ionized, by the ultraviolet light from the sun, but it is not yet possible to assign a cause to the F region.

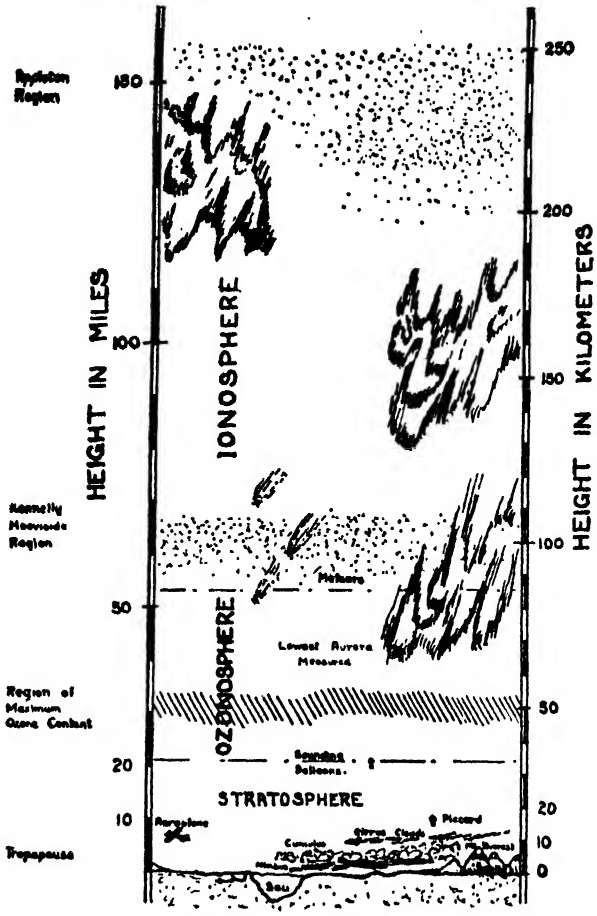


Figure 2: **A scale drawing showing some atmospheric phenomena that take place at different altitudes noted**

It should now be clear that it is necessary to determine in due course the different types of radiation responsible for (a) the ozone layer, (b) the Kennelly-Heaviside layer, (c) the Appleton layer, (d) the more occasional and local auroral displays, all of which are attributable to the sun's activity. There is a yet more difficult problem with respect to the cosmic rays and the bursts or showers of ions to which they give rise. Sometimes 100,000.000 ions occur at a single outburst.

IN the upper atmosphere, the pressure is so low that the molecules are quite far apart, and if an electron is detached from a molecule by some type of radiation, it may have to wander a long way before it can find a partner in a positive ion; or it may find a resting place on a neutral molecule, so that the pair become a negative ion. While free, the electrons are so small and light, compared with their electric charge, that they are readily made to oscillate, or dance in rhythm, with any electromagnetic waves that are passing them. Curiously enough, the group of waves travels the *faster* in consequence, so that an electromagnetic wave entering these ionized regions obliquely has the upper part wheeling faster than the lower, until the wave front is turned around and proceeds downward to the earth again. However, much the same sort of thing happens every time you look into an ordinary mirror or looking-glass. There also the free electrons in the mercury at the back of the glass are able by their stimulated motion to return to you a fairly faithful image of your face.

Radio signals will also bounce to and fro between the earth and the reflecting regions, proving that the earth is an admirable radio reflector. The total path for eight such reflections, which have been obtained from the F region, must exceed 2000 miles.

In old days the heavens were deemed to be eternal, changeless and perfect, so that the discovery in the days of Galileo that there were spots on the sun came as a shock to medieval thought.

The face of the sun is a turbulent place at the high temperature of 6000 degrees, Centigrade. Black spots appear on it, sometimes large enough to be seen through a darkened glass with the unaided eye, and broader than the diameter of the earth. The number of these spots follows the same 11-year cycle as the frequency of the aurora. At the beginning of such a period the face of the sun may be practically without spots. In due course a few appear in middle latitudes on both sides of the sun's equator. There is a steady increase in number, the spots become nearer to the equator, and they disappear when at the lowest attained latitudes.

These relatively cool, dark whirlwinds reveal magnetic properties discovered by Hale through the Zeemann effect, and they may perhaps be compared with the "lows" or cyclones which so often bring storm, rain, and flood. The periodicity of sunspots, auroras, magnetic storms on earth, and changing radio phenomena, has been found to hold good for the fluctuations of the white polar caps on the planet Mars, and even for a cycle of ring growths in the great and ancient trees of western America.

MOST people are familiar with shooting stars or meteors, and many have seen in their lives dozens or hundreds of them, yet it always comes as a surprise to learn that no less than 20,000,000 of them every day plunge into our atmosphere with velocities ranging up to 130 miles a second. Sometimes these visitors are but the size of a pin's head, and at other times they are large enough to pierce the atmosphere and reach the earth. The famous Arizona crater may have been formed long ago by a giant meteor; the crater is 1400 yards across and more than 500 feet deep. In 1908, a great meteor, estimated to weigh 130 tons, fell in Siberia and devastated by its great heat hundreds of square miles of country.

The elevation of most frequent meteoric displays is about 40 to 60 miles above the earth. It is somewhere in this region that the temperature rises according to the theory of the reflection of sound waves, to which reference has already been made. Sometimes the meteors are of iron, sometimes of stone, and it is not easy to understand how they become red or white hot when rushing through cool air, how indeed they acquire more heat from the bombardment of molecules than is carried away by them. An experiment in the laboratory of a similar character would be difficult to make, because our projectiles achieve a speed of a few thousand feet a second, as contrasted to meteors having velocities of many miles a second. It must be remembered, however, that meteors are luminous in *rarefied* air at altitudes varying from 100 to 30 miles.

It will be gathered that the study of the Northern Lights is bound up with other physical phenomena in the upper regions of our atmosphere, and that progress can best be made, as in other branches of science, by advance on a broad front.

●

Just what is this new science called "rheology"? It is the study of the fact that everything flows. Solid materials slowly flow, as is more and more realized. An early article will explain.

Can Man Create Life?

Important Discoveries... How Disease Viruses May Originate... The Newer Understanding of Viruses and its Significance... Is Life Only a Mechanism?

By BARCLAY MOON NEWMAN

CAN man create life in the test tube? This question has for centuries fascinated men of science and, indeed, all who have given it a moment's thought. Yet the more conservative scientists have always held any hope of success up to ridicule.

Today, ridicule is changing to wonder. Startling new discoveries apparently indicate that man-made life is straight ahead down the path of present research. Two related groups of findings suggest that at least certain simple animate varieties will eventually be manufactured in the test tube. The way toward the ultimate creation of more complex forms seems also to lie open. The view of the world as a vast system of mechanisms gains another triumph, and we may well doubt whether there are limits to the progress of science in such a mechanistic universe.

One line of evidence emerges from the discovery of the nature of the strange germs known as viruses; the other, from the newer understanding of the equally uncanny molecules, the enzymes, which are found as activators and regulators of chemical reactions within the living organization. The two lines of evidence are closely related because both virus and enzyme are not only molecules of tremendous size, but also protein molecules. That is, both are great clusters of atoms, or chemical compounds, similar in construction to hemoglobin (the pigment which makes blood red), to albumin (chief component of egg-white), and to all the innumerable other proteins occurring throughout the world of life and acting as the foundation-stones of animate existence. No organism is possible without protein. Protein is the framework about which the living chemistry is built. Hence, those who would synthesize a live being must first of all learn how to manage proteins.

Typical viruses are the various germs which cause infantile paralysis, smallpox, influenza, and the common cold. Each individual germ turns out to be a big, complex molecule. To the scientist this discovery is startling—but why? A molecule is a fairly stable organization of atoms, chemically combined in definite proportions. Every molecule therefore has a definite structure—a definite chemical formula. Chemists know how to determine formulas representing the architecture of molecules, and have set forth hundreds of thousands of formulas. And once chemists find the formula of a given compound, they are able to take steps toward synthesizing the molecule. Hence man can find the formula for a virus, then proceed to the test-tube manufacture of the germ. Then man will have created life—provided you admit to begin with that a virus is a living thing.

Is a virus truly alive? Until recently, every one who was aware of the existence of such germs thought of them as living agents of death, similar to—though much simpler than—lowly plants, the bacteria. Virus-germs remain indubitably agents of death. They are transmissible from host to host, wherein they reproduce, become as numerous as the sands, assume control of life reactions in many tissues which they invade, cause illness, destroy the host.

Nevertheless, each virus-germ, being only a single molecule, is far simpler than any other known germ, such as a bacterial cell, which consists of thousands of molecules of many different kinds. Bacteria range in size down to diameters of approximately one fifty-thousandth of an inch. But we could crowd 250,000 of the largest viruses single-file along an inch, and 2,500,000 of the smallest.

BACTERIA, too, like all things clearly alive, have a cellular structure—each bacterium has an outer thin wall enclosing protoplasm, the intricately organized life-material common to all plants and animals. This protoplasm absorbs water, soluble nutrients, and frequently oxygen through the cell wall, and gives off wastes, such as carbon dioxide and other products characteristically side-issues from, and evidences of, vital activity. Thus, bacteria respire, while viruses do not. Bacteria, as they carry on their biochemical reactions, develop heat—viruses do not. In short, bacteria are examples of life on a plane where whole systems of molecules—many almost as complex as the entire virus organization—co-operate to make a living symphony. The virus, then, is comparable merely with a single *tone*—being always but a lone molecule, however active and however amazing.

Moreover, virus molecules can be extracted from diseased tissue and afterward concentrated into quite solid and apparently quite lifeless crystals, each made up of a great number of closely-packed, separate molecules. And, though the virus thus crystallized still is infective when allowed to enter a healthy host, no virus has yet been known to multiply outside of living cells. Even if man is able to keep the germs alive in the test tube for considerable lengths of time, it appears—at least at our present first sight—that a virus cannot develop or long exist in the absence of other and previously existing life.

It is even suggested that a virus is a product of cell activity gone wrong—a dangerous, automatically reproducing molecule at times thrown off by accident from the body's all-too-fragile and hazardously intricate mechanism. This hypothesis maintains, for instance, that a cell, entirely germ-free, can by mere chance throw off a splinter from a bursting protein. This splinter, itself protein and very near the threshold of life—if not entirely alive—is nothing other than a virus, a germ suddenly come into being amid formerly normal life. Death leaps full-formed from life.

Perhaps here is the astounding explanation of the birth of at least some virus diseases. In most interesting fashion, Dr. E. V. Cowdry, professor of cytology (the science of cells) at Washington University School of Medicine, sums up these considerations:

"The chance of the formation of viruses at rare intervals may be a kind of hazard or risk which Nature runs as chemical and physical forces are harnessed in the evolution of life on earth. Human beings are subject to a greater variety of virus diseases than are any other animals. Many viruses spread to us from lower forms, but some may have originated in our remote ancestors. Consider the female sex hormone, theelin. Here a risk is balanced against a gain. The production of this substance has facilitated the differentiation [evolution] of higher forms and of man. The hazard

which Nature has run to achieve this result is that theelin is a dangerous substance closely related chemically, and also in its action, both to an essential vitamin (D) and to substances that can cause cancer."*

Certain complex compounds of carbon, including several compounds derived from coal-tar, upon being constantly applied to the skin of experimental animals (as to the ears of rabbits), bring on cancer of the skin. The supposition is that such cancer-causing chemicals achieve their dire effects by upsetting the protein chemistry of the skin cells. The unhealthy cells may then produce protein fragments within themselves. And these fragments would be just-born virus molecules, which are capable of taking over the command of the cell's chemistry and running it to their own lethal purposes. The cells, rendered mad, proliferate without restraint, build up horrible and horribly painful masses of tissue. And ever the weird virus makes more and more copies of itself.

IN other diseases, the virus must be introduced into its victim from the outside, an infected individual serving as carrier of the germ. So, in the instance of the common cold, Dr. A. R. Dochez, of Columbia University's College of Physicians and Surgeons, takes material from the noses of persons with heavy colds, forces the germ-ridden substance through fine filters, and so gets rid of all bacterial balls, rods, and spirals. The filtered material, touched to the nasal membranes of healthy persons, gives rise to new colds. The virus has been transmitted, can now work its evil.

The virus molecule attacks cell after cell, therefore it must move from cell to cell. Must it not be alive? Not necessarily: many a non-living molecule wanders to and fro within the tissues. Sugar migrates into the liver, and out again, back into the blood. The virus is capable of movement in the proper medium, yet this is no decisive reason for regarding it as a live thing.

After all, then, are we to conclude that the virus is not really alive? Definitely: No. Thus far, we have considered the whole argument against the conception of the virus as a living entity. But we have not explained away the strange powers of these big molecules—reproduction, multiplication, the ability to act as a parasite and to regulate the activity of myriads of lesser molecules. And, in addition, we cannot ignore the fact that viruses *do* move, whether or not their movement is dependent solely upon purely mechanical—that is, physical and chemical—conditions involving their nature and the state of their environment. The virus may migrate solely under the proper electric influence, because of electric attraction or repulsion. Nevertheless, no scientist for a moment doubts that *our* movement depends, in the last analysis, solely upon the physico-chemical reactions occurring within our muscles.

The virus has other properties characteristic of life. For one thing, a virus can mutate. That is, it can suddenly alter or be altered to a new variety. This new variety of virus can also perpetuate itself through host after host, indefinitely. We are all familiar with sudden increases in the virulence of virus diseases. Influenza epidemics are more severe during certain winters than during others. Presumably, the influenza virus has undergone a slight change in chemical structure, enabling the germ to play greater havoc with its victims. Smallpox virus is cultivated in the body of the heifer; a less virulent germ of cowpox is the result. Cowpox, introduced as a vaccine into man, induces only a light attack of smallpox—and we happily develop immunity to possible later attacks of the most potent smallpox virus. As the virus can mutate, it therefore exhibits evolution, even as all living forms.

Sometimes the virus is said not to be alive because it can multiply only in the presence of previously existing life. Judged on this basis, however, we ourselves cannot be called alive! Besides, the science of viruses is scarcely born. No one need doubt that coming knowledge will enable us to concoct non-living mediums in which viruses can reproduce practically endlessly.

THE final decision as to whether or not viruses are alive is academic hair-splitting, and depends ultimately upon our present unscientific definition of life. Any definition of life—never scientific or altogether accurate—is always no more than a listing of the activities *commonly* observed in many living things. There are phases in the life of every individual when we cannot tell whether the organism is dead or alive. What expert can say when a dying thing is actually dead? When a cell or a man dies, death does not occur "all over, all at once." Parts of a dead man, though consciousness and soul have fled, can be cut out and cultured immortally. Dormant spores are so sound asleep that we are unable to discover their vitality until we force them to change their structure and chemistry, and make them breathe and grow. What botanist is sure that this growing spore was not a non-living organization a moment past? We may give it life when we warm it, water it, feed it, irradiate it. The mere potentialities—the proper composition for life—may be there in the dormant spore. Our manipulation may be the precise influence necessary to lift the organization to the plane of quickness.

In the light of its astounding capacities, in the light of its protein nature, and viewed against the background of all distinctly non-living arrangements of atoms and against the background of all living organizations, the virus molecule must for all time appear to be a transition form between non-life and full-flowering life—but a form vividly more alive than not. There is no denying that, in many respects, the virus is a living thing, however simple. Except for its structural simplicity (and it is only comparatively simple, being a cluster of hundreds of thousands of atoms), and except for the function of respiration, which includes heat production, the virus molecule possesses every attribute of lowly life—life as observed among the lowly plants, the bacteria.

On paper, then, the virus shows up as a living thing, a transition form just inside the threshold of life. For the virus we have been able to check off life-qualities enough against the list of characteristics which together constitute our present definition of life and together provide a means of deciding what thing is alive and what not, to convince us that we are dealing with a vital gang of atoms, however low in the animate scale. Nevertheless, though the virus may today represent a transition form, it may or may not have true evolutionary significance. Can we demonstrate that, in all probability, the virus or a very similar organization was a stage in the evolution of the higher forms, ascending to human atom-constellations? Can we safely assume that, when we are synthesizing such odd gangs, we are also on the way toward creating higher types of organisms whose structures are built up of the units, the cells? If we can perform this demonstration and attain this assumption, at once we emphasize the place of the virus in the world of life and pierce closer to the secret of the cell, which has all the characteristics of life.

DR. R. G. GREEN proposes that the virus is a degenerate. He compares it with other but more complex parasites, such as the tapeworm, wherein ages of easy living inside the mammalian intestine have brought about loss of formerly better-developed digestive system, sense organs, and other organs unrequired in the warm, food-filled peace of the host's body. According to Green's theory, even in the beginning the virus was a simple, one-celled creature; lengthy parasitism deprived it of every equipment save that necessary to survival as a reproductive, multiplying skeleton of its former self.

But, to explain the origin of the virus, why run up the scale of life only to run down again? Green merely makes the problem more intricate. He forces us to explain in terms of evolution and devolution—and devolution can only follow

*Scientific Monthly, September, 1937.

evolution. If the virus skeleton was once clothed with flesh, we have to account for the formation of that flesh. On the other hand, if such a skeleton can do all that the virus does, why clothe it, only to render it naked once more? The essential point is that the skeleton *is* the virus. And this skeleton, this virus, this living molecule, is—even in Green's thought—the chief part and the logical starting point of higher life. We recall that protein is the framework, the reproducing and controlling skeleton, about which life chemistry is constructed. Before we develop Green's possible degenerating cell, we must first develop the starting molecule.

But did not Cowdry conclude that the virus may at least sometimes arise as a mighty, dangerous splinter cast off by erring protein chemistry, the chemistry of the cell? Yes, and though the virus is to attack the cell which bears it, and though this cell too is in a sense a degenerating live thing, still this suggested source appears a likely one. Why? Cell protein and virus protein are alike. Were they not blood relatives, it would not occur to us that viruses can emerge from cells' protein. They are, in fact, so closely alike that the highest refinement of modern analysis fails to elucidate the nicer differences between the virus protein-molecule and the cell protein-molecule. Above all, their phenomena—their systems of behavior—are basically the very same, and also unique. In all of chemistry's universe, no other molecules even approximate the lively manifestations of these proteins, unique molecules, life's sole possible start and life's sole possible framework. So, it is easy to think of virus organization arising from slight changes in cells' protein-molecule. So, too, it is easy to think of cell protein taking its rise from virus or related atom-clusters.

Related atom-clusters are the particular proteins, the enzymes, the stimulators and regulators of live chemical reactions. And it is here that we draw upon our second line of evidence that man will soon be manufacturing life in the laboratory: the evidence from the new lore of enzymes, molecules as uncanny as the viruses, their kin.

IN warmth and suspended in a watery medium having the proper concentrations of salts and acid or alkali, enzymes grapple with great molecules—starch, fat, protein—and burst them into lesser configurations of atoms. But enzymes are constructive as well as destructive. And interest is increasingly focused on this second activity of theirs rather than on their earliest-noted phenomena. Alter the concentrations of the substances swimming in the watery medium, provide spare parts with which the enzyme may play, and lo!, the enzyme begins upbuilding exactly the architectures which it was just now demolishing. The enzyme sorts the fragments, lines them up, hooks them together—in short, synthesizes a new large molecule out of tiny ones.

Further, enzymes have lately been shown to act much more gently, to bring about much more delicate changes. Thus, an enzyme can cause a subtle shifting about of small groups of atoms which are part of, and remain part of, a giant protein fellow. The giant may so be made a more active or a more sluggish thing, depending upon its first nature and the nature of the enzyme.

An enzyme of a certain type can ferry an atom or a group of atoms from one substance to another. In this manner, oxygen is subtracted from one compound and is added to a second. Simultaneously, both compounds, being altered chemically by loss or gain, are unavoidably made into new chemical entities. So an enzyme is again seen to be a remarkable modifier.

Enzymes, of diverse kinds, can do far more—can labor almost incredibly. They can effect the production, reproduction, and multiplication of atom-gangs of many sorts. And they can themselves reproduce and multiply, even as virus. Their phenomena take place in time as well as in space: we must concede that enzymes can pace the processes in which they participate—or, as you may prefer, which they rule.

PERHAPS most striking, if not most significant, among the enzymes' powers, is the capacity of autosynthesis—the power to create oneself. An enzyme—active molecule—can spring full-fledged from inactive precursor. A step has been taken, up the ladder of life. The leading investigator of enzymes, Dr. John H. Northrop states: "Some filterable viruses are probably enzymes which possess the property of forming themselves under the proper conditions."

In handling enzymes, men of research have been manipulating the very life-stuff, the most meaningful life-stuff, the sole *active* stuff of life. Here are organizations with every imaginable requisite for co-operation upon every level of life. Nowhere are comparable molecules or molecules even remotely so potent. We cannot escape calling many of them alive: *living molecules!*

Yet, a living molecule is not a thing of the same order as a living cell, constituted of hundreds and thousands of molecules—the numerous pieces reproducing as a unit, when one cell gives rise to another. How are we to jump the gap between an individual living molecule and a cell, which is apparently dead unless it is all together, no part being alive unless the whole is living? There is no gap over which we are forced to jump. There is a smooth slide up to life, even up to cellular life.

We have not exhausted the abilities of these astounding things, our enzymes. The enzyme is a giant molecule, hence a sizable particle just beyond the limit of the microscope. It is a general characteristic of particles of approximately this size that, when separate and suspended within a medium, they attract lesser particles—little molecules, fragments of molecules, and even atoms. If the giant reproduces, another giant is among the tiny molecules and still tinier atoms. And again these bits will form a galaxy about a big fellow, our second giant. What has happened? Not just one molecule has reproduced—an entire system has been duplicated! Such a system is no less than a primitive cell, alive because of its living nucleus, the protein enzyme!

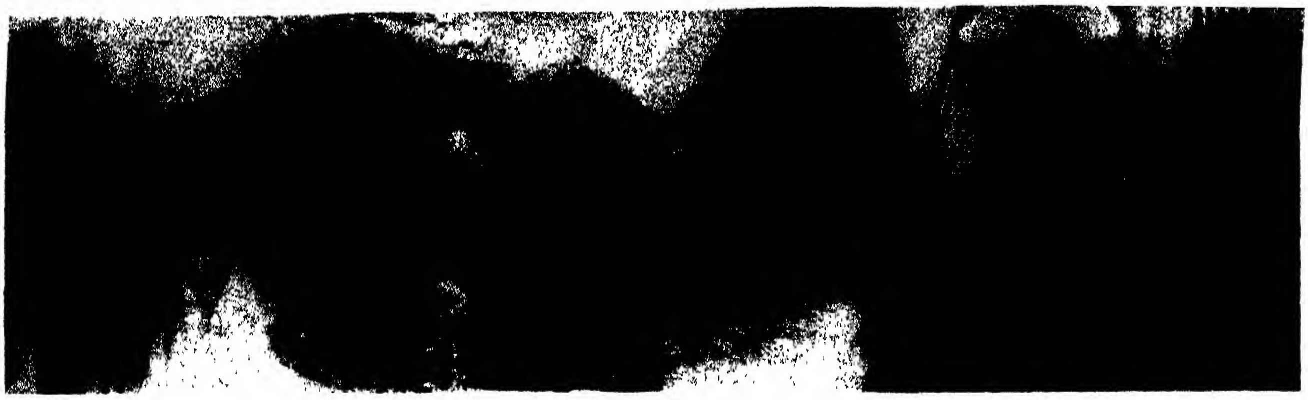
WE have won to the plane of the true cell. The co-functioning of several loosely-linked enzymes, all enclosed within a film, and the concentration of nutrient, energy-yielding bits within that same film, and the concentration of other bits adhering to the cell-membrane—these events yield a still loftier event: a respiring, moving, thinking cell—a brain cell of man.

Therefore, when such brain cells, co-working within men of research, gain additional discovery of their own nature, we shall see not only living molecules synthesized within the test tube, but, beyond, man-made cellular life.

Since 1859, when Charles Darwin demonstrated that Nature creates the new merely by accumulating subtle modifications of the old, men of science have used this thought to make uncountable discoveries. Physicists today are showing how the atom is created by subtle union of the properties of lesser things—electron, positron, proton. Chemists are setting forth the creation of molecules by union of atoms. and the construction of new molecules by subtle re-arrangements of atoms making up the old.

Now biochemists and biophysicists fascinate us with pictures featuring the play of electrons, atoms, and molecules. Within a bed of water, and nothing more or less mysterious, atoms become linked into chains: molecules. Some of these molecules are enzymes, which stimulate the atom-chains to cluster into tiny galaxies and out of such galaxies to form huger webs, giant molecules of protein.

The easy glide up to life has begun. The giant proteins are themselves very like the enzymes which stimulated them to take shape. Hence these giants stimulate the linkage of still other smaller molecules, and so force duplicates of themselves to arise. Life-like reproduction is now a reality. The harmonious interplay of particles at the threshold of life continues. Soon, as if by a miracle, that famous doorway is crossed. By subtle modifications of the old, the new is at hand: Life.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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Electrical Sense of Balance

A UNIQUE electrical "sense of balance" for automatic leveling is an important feature of the newest giant shovel for coal strip mines—said to be the world's largest structure capable of overland movement on its own traveling "foundation." An arrangement of four tiny mercury switches on a plane table acts to keep the entire structure level even when the four tractor bases are moving over uneven footing. Automatically, with every change in ground level, hydraulic jacks go into operation to raise or lower the four "legs" of the 2,500,000-pound unit to an even keel.

An electrical sense of balance keeps this 33-yard shovel on a level keel

The largest electric shovel in the world, this Bucyrus-Erie stripper has a dipper capacity of 33 cubic yards, the equal of capacity loads for ten or more five-ton trucks. Towering more than 100 feet in the air, it has a 105-foot boom, and could easily dump its load on the top of a seven-story building. The total motor horsepower is some 2400, furnished by 32 motors mounted within the structure.

Under each corner of the base of this shovel is a huge tractor unit, built like a military tank with twin crawler belts, and individual electric drive. Over half a million pounds of working weight is distributed over each of these four tractors, so that the footing is likely to settle under one or more of the supports in spite of their great tread area. Ordinarily, such settling requires time by the pit crew in handling, tightening, and loosening the hydraulic jacks used to level the machine.

In the new stripper, an independent, high-pressure, electrically driven pump is connected to each jack, maintaining the pressure required to level the machine. At the propelling station, four General Electric mercury switches are mounted on a special control table to provide automatic operation of these pumps.

One of the four mercury switches of the electrical sense of balance

The patented leveling control system provides one switch at each corner of the table, each switch acting through boosters, to control completely the interlocking and electrical devices and fluid values. When the shovel tends to settle, the horizontal control table tilts with the machine, causing the mercury to flow from one end of the switch tubes to the other, completing a circuit which controls operation of the electric pumps.

As the hydraulic jack returns the stripper to level, releveling the control table with it, the mercury switch resumes its open-circuit position. This system of automatic leveling results in a considerable saving in power consumption, doing away with the need for swinging the machine "up-hill." In addition, elimination of interruptions in the digging cycle reduces delays.

REFINEMENT

TALK of the meat packers saving everything but the pig's squeal—the volume of refined petroleum products now equal within a fraction of 1 percent the volume of crude oil run to the stills.

New Source of Ultra-Violet

A NEW, highly flexible source of ultra-violet radiation, consisting of a quartz-tube mercury vapor arc of improved efficiency mounted within a special reflector on a portable laboratory stand, has just been announced by the General Electric Vapor Lamp Company. The unit is operated from any 120-volt or 220-volt A.C. line, through a portable auto-transformer supplied as part of the complete assembly. The sealed mercury vapor tube has high radiation characteristics in both the near and far ultra-violet zones, without the high heat losses and operating and maintenance problems inherent in

New self-starting ultra-violet light source, with transformer at the right

open arcs. Rated operating life of the new tube is 2000 hours.

In contrast to previous models, the new Type H Uviarc is self-starting, requiring no tilting nor use of auxiliary moving parts. It is also "universal-burning," operating with equal efficiency either vertically, horizontally, or in any other position. The six-inch arc tube operates at 360 watts out of a 410-watt input supplied to the auto-transformer, or 87 percent of the total, whereas in former alternating current operated units, the arc wattage was below 65 percent of the overall input. Radiation at all wavelengths in the ultra-violet region is stepped up accordingly.

Cheap Magnesium

LITTLE more than six tenths as heavy as aluminum, magnesium has attracted attention as a possible light structural metal. Its cost has been a serious drawback to its wide use but recently a new method of manufacture has been developed which is expected to make it cheaper than aluminum. In alloys with aluminum and manganese, as well as other metals, magnesium has already proved useful; production at low cost is expected to enlarge its applications *D.H.K.*

Development of a Gear Shift Control

THE motoring public accepts new features of design with little thought and still less knowledge of the great amount of detail work, and the weeks, months and sometimes years that have been spent in perfecting them.

In 1931, engineers of Pontiac Motors began experimenting with various types of design that would remove the gear-shift lever from the conventional place in the floor and put it up under the steering wheel or under the dash—at least out of the way of the front-seat passengers.

Since 1931, 15 different types of remote-control gear shifting devices have been designed and tested. None of them were adopted, however, although full-sized models were made and tried but found wanting. Some of them are shown in our photographs.

The first device in 1931 employed cables and a long shift lever attached to the under side of the dash.

Then came a series of models in which a standard gear-shift lever was bent forward under the dash and a horizontal rod attached to the top by a pin or a ball and socket joint and brought forward through a wire track or an opening in the dash.

In 1935 when it was known that the 1937 model cars would have wide, three-passenger seats, the effort was redoubled to develop a satisfactory remote control gear shift in time for that model.

The position of the hand brake having been changed in the 1937 models, it was hoped that the gear shift could be moved out of the way at the same time, thus removing every obstruction from the front seat.

A number of other designs were worked out and tested until, finally, the safety shift gear control was approved late in 1936 and tested early in 1937. It was designed by Arthur A. Rubly, a Pontiac engineer. Between that time and the date of its final approval, six different variations and refinements of the first design were built and tried out in cars.

8-Millimeter Film Editor

A COMPLETE film editor which consists of a rewinder and splicer plus a special 8-millimeter film viewer has been announced by Bell & Howell Company. This viewer is so simple and compact that one

For editing 8-millimeter movie film

wonders why no one thought of it before. Actually, it took the company more than two years to design the editor, for simple things are often the most difficult to do well.

The viewer might be described as an inverted, modified cone, hinged at the small end and terminating at the large end in a ground-glass viewing screen 1½ inches wide upon which a brilliant upright image of a single frame is produced. This viewing screen is well shielded by a "sunshade," permitting a desk lamp or room lights to be used without interference.

The viewing cone swings backward from its base, out of the way entirely when the film is being wound from one reel to another, permitting easy placement of the film in its channel when the viewer is to be used. The lamp is entirely enclosed, except for the small opening through which its rays pass to the optical units in the viewing cone, and there isn't a chance for glare in the eyes of the operator. With a convenient switch on the cord, the lamp may be turned off while the operator is splicing.

The film viewer can be purchased separately, for use with the rewinder and splicer, and it is also available with a viewer elevating bracket and a rewinder elevator block for use on previously-purchased Model 136 and wood-base splicer and rewind combinations.

MOLECULES

CHEMISTRY students were formerly taught that all matter was made up of atoms and that when atoms of various elements were combined together they produced molecules of the resulting compound. Today scientists recognize six different types of chemical combinations, only one of which has old-fashioned orthodox molecules.

Styrene Resins

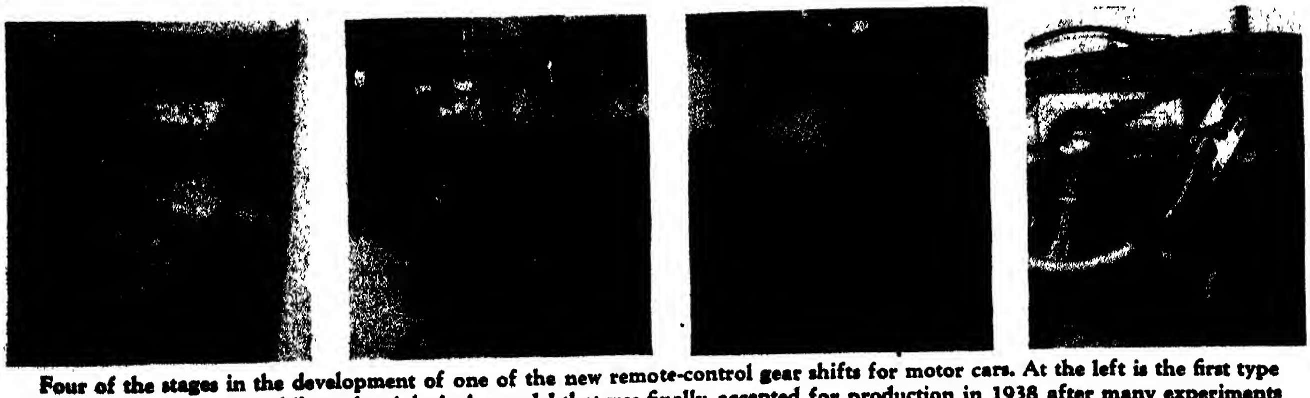
A NEW family of glass-clear resins which are easily machined and molded has recently been produced from styrene, a derivative of coal tar. The resins have a very high index of refraction, are unaffected by alkalies and by weak acids, and are used in paints, varnishes, lacquers, molded parts, and electric insulation. Their optical properties are particularly interesting and suggest their use in lenses. *D. H. K.*

The Expanding Cranium

STRIKING confirmation of the discovery that the human head and presumably the brain—may grow throughout adult life, which was first reported last year by Dr. Ales Hrdlicka, Smithsonian Institution Curator of Physical Anthropology, has just come from 84-year-old Sir Flinders Petrie, one of the most distinguished of living archeologists and Egyptologists.

Dr. Hrdlicka has received a letter from the famous British scientist telling of the curious increases in the size of his own head between the ages of 20 and 60. He has kept a record of the sizes of hats he bought.

At 20, Sir Flinders reports, he wore a 6½ hat. It was a good, comfortable fit. At 30, the smallest size that he could wear com-



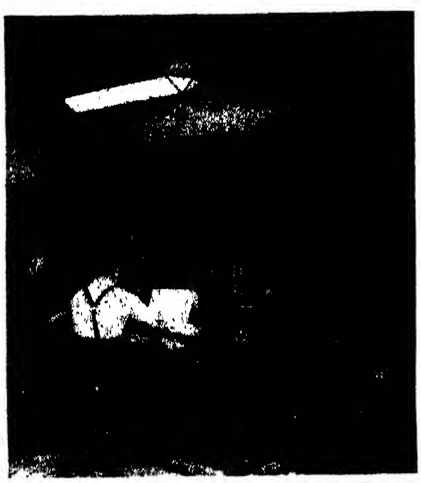
Four of the stages in the development of one of the new remote-control gear shifts for motor cars. At the left is the first type that was tried in 1931, while at the right is the model that was finally accepted for production in 1938 after many experiments

fortably was between a 7 and 7¼. At 40, his hatter had to supply him with a 7¼. At 50, he required a 7½. Even since then his head may have increased because he finds difficulty in making any standard size hat fit easily. He is, he tells Dr. Hrdlicka, quite sound and normal.

The record is of more than usual significance because of the incessant and continued intellectual work of the English archeologist throughout his life, and which is still continuing. It would be especially interesting, Dr. Hrdlicka points out, to obtain similar records from other men of comparable intellectual activities.

Silencing a Motor Test House

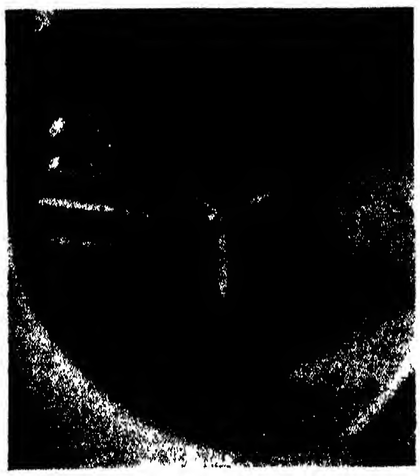
THE new Pratt & Whitney Engine Test House is surely a symbol of a modern age. Aircraft engines already develop 1500 horsepower. The prediction has been made that they will develop 3000 horsepower within a very few years. Silencing engines of this vast power, and at high speeds, is a difficult, two-fold problem. The neighborhood of the test house must be protected from disturbing noise, and the engine control room must be made entirely livable without in any way hindering control and observation of the test chambers by the engineers. The Pratt & Whitney Test House has achieved both objectives, besides providing excellent means of studying the power and fuel consumption of the engines and the characteristics of the propellers.



A corner of the control room in the new motor test house described

The new building houses four test chambers, in each of which 1500-horsepower engines swinging 13-foot propellers are probably under test today; it is able to accommodate 3000-horsepower engines swinging 23-foot diameter propellers in its circular chambers. Circular chambers, of course, minimize the interference of rectangular or square chamber walls. The outside of the building looks like something out of an H. G. Wells moving picture. The exterior walls are of concrete, 18 inches thick. The entire structure contains 4600 tons of concrete and 160 tons of reinforcing steel. The four test chambers are on the lower level and are grouped around a central control room. The best way to visualize the whole set-up is to look at the cut-away sketch. The central control room is equipped with four control desks and a new type of double sound-proof window through which the test chambers can be observed. One of the photographs shows a corner of the control room with one man observing the instruments and the man at the left looking through the sound-proof window. A further noise reduction measure in the control room lies in the use of an acoustical ceiling, suspended far enough below the concrete ceiling to house the fresh air and exhaust ducts. The noise level in the room is 78 decibels, which is far below the figure for a New York subway and allows comfortable conversation.

The other silencing problem, that of keeping noise away from the neighbors—which really means all the inhabitants of East Hartford, Connecticut—has been accomplished by the use of very tall exhaust and intake stacks for the test chambers and by vibration isolation of the motors. At first it might be thought sufficient only to provide exhaust stacks, but sound travels in every direction and the inlets must also be soundproofed. Both in the inlet and in the exhaust ducts a new sound-absorbing material called Calistone is suspended in huge parallel rows.

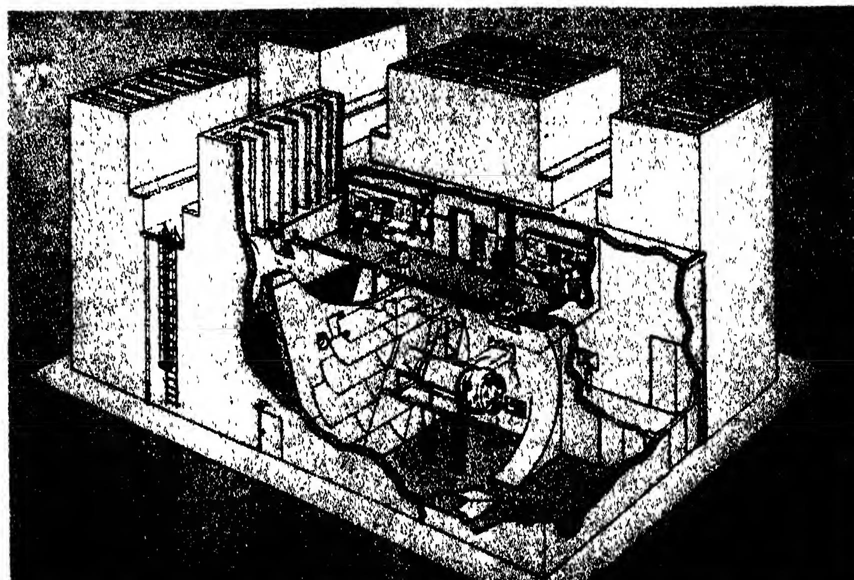


Front view of an engine in the test chamber. Cables are rubber mounted

To isolate the motors and to prevent transmission of vibration, a flexible suspension system has been used. To take up the propeller thrust, some of the cables are crossed, allowing the thrust to be taken up without the introduction of struts. A curious feature of the design is that the lower portions of the exhaust and inlet adjoining ducts are in the form of an "A." It is within this "A" that stairways are provided from the control room to the test chambers.

Side view of the engine suspension. Note sound-absorbing strips in duct

There are several other features of interest in the design of the 200,000-dollar test house. For example, the test chamber can be cut off from the outside air by lowering two electrically operated heavy canvas curtains, so that the chamber can be rapidly heated to a comfortable temperature. A working platform supported from the cables is permanently installed on each stand, and a telescoping portion of this platform can be extended forward and around the engine, when it is stopped for adjustments. The carbureter air is taken in from the roof and led down through large ducts just outside the ends of the control room and thence through temperature regulators to the engine. The quantity of air used is measured by a system of calibrated orifices. Air to the propellers enters the intake stacks at the corners of the building and, after leaving the engine, passes through a series of heavy steel baffles to the exhaust stacks. Incidentally, we must not forget to mention that the propellers may actually be a greater



Cut-away sketch of the test house, showing one of the four test chambers

source of noise than the engines, owing to the high tip speeds of the blades which approach the speed of sound during some tests. No wonder that the noise level in the test chamber is 135 decibels (that is to say, a good deal louder than a boiler factory).

There are also arrangements for measuring fuel and oil consumption, rate of oil flow through the engine, and so on. There are 48 thermocouples for measurements of the temperatures at various points of the engine; the electrical currents generated by the thermocouples are led through wires to the instrument boards in the control room. Of course the control boards are also provided with tachometers, fuel and oil pressure gages, remote reading thermometers

for measurement of oil and carbureter air temperatures. A special torque meter or dynamometer is also provided.

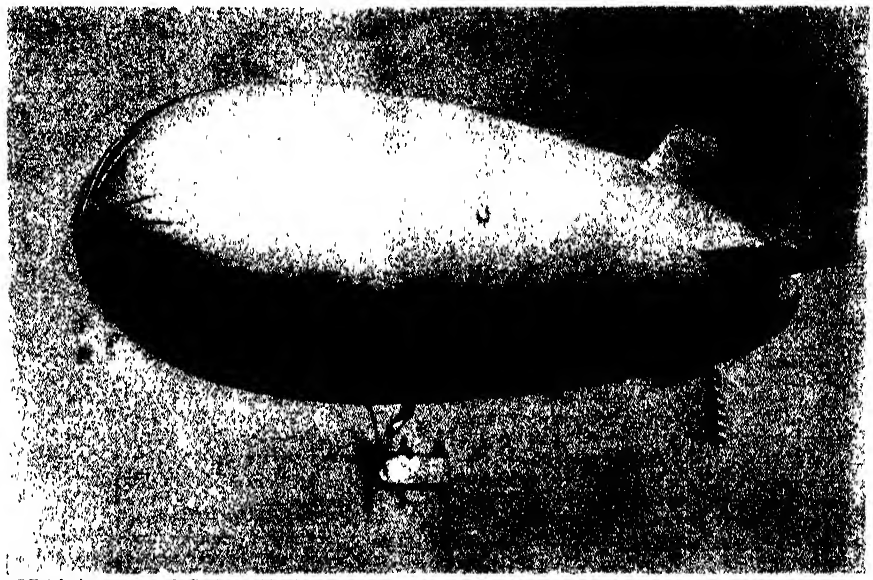
All in all, this is a magnificent example of the technique of modern experimentation. No task is more fascinating than to conduct a test under such conditions and to learn rapidly and comprehensively all that a new engine and propeller combination can do.—*A. K.*

Who Really Inspects our Airplanes?

On January 1 of this year there were 17,681 pilots and 9152 aircraft holding active Department of Commerce certificates. Now, while the Bureau of Air Commerce is ever concerned with safety, and while its inspectors are a splendid body of men, it is physically impossible for them to give every airplane in service a thorough inspection, even if only once a year. What happens is that the visiting inspector asks the mechanic in charge of a ship when it was last overhauled, what he thinks of her condition, and what he wrote in the log. He then certifies the aircraft. But perhaps this is the best way after all. Why should not an experienced and licensed mechanic know far more about his plane than any visitor from Washington?—*A. K.*

Tests of a Motorized Balloon

During the World War, captive balloons or "sausages," as they were frequently called, played a useful rôle in artillery observation, even though they were frequently shot down. These captive balloons, stubby,



Official photographs, U. S Army Air Corps

Left: **The *C-6* being released as a kite or captive balloon.** ***Above:*** **The same balloon, equipped with an airplane fuselage and motor, functions as a small blimp.** ***Below:*** **Attaching the motorized balloon to a mobile mooring mast in a manner similar to that employed for larger airships**

with inflated lobes at the rear for stabilizing purposes, have remained practically unchanged to this day. But to move the "sausage" cross-country when changing its station for observation purposes, it is necessary to "walk" it; power lines, trees, and other obstacles make progress quite difficult. The new motorized balloons, like the *C-6* which has undergone successful tests at Fort Sill, Oklahoma, is more popular with the Army Air Corps. The balloon is like a small blimp, with a true airship form. Equipped with an observation basket and moored by a cable to a winch, it functions just like a "sausage." When the station is to be changed, basket and cable are disconnected and a small fuselage, like that of an airplane, is attached in lieu of the simple basket. With a 90-horsepower Lamber engine and a two-bladed propeller, the *C-6* can fly to another destination at a speed of over 40 miles per hour. Meanwhile the winch is sent by motor truck.

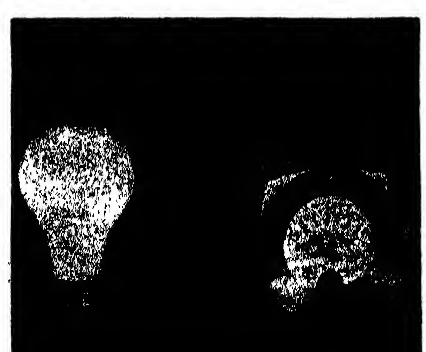
One of our photographs shows the balloon with its basket, being released for kite balloon duty. In another photograph, it is flying like a small airship; a third picture indicates that the *C-6* may be moored to a mobile mooring mast just like its more ambitious brethren, the huge rigid airships.

The *C-6* is 107 feet long, 30 feet in diameter, and contains 52,000 cubic feet of helium. The old type sausage was only 95 feet long, 27 feet in diameter, and was inflated with only 37,500 cubic feet of hydrogen.—*A. K.*

Static Detector

In the laboratories of United Air Lines there has been developed an interesting static meter which is essentially a vacuum-tube electrometer with associated controls. It is intended for operation from a 200-volt radio dynamotor and a 12-volt aircraft storage battery. The unit contains two voltage regulator tubes. The knob on the right side of the meter as shown in the photograph allows a number of different radio ranges to be used, depending upon the intensity of the static charge. The device may be connected to any radio antenna on the aircraft, but for testing purposes United uses a smooth metal rod, ten inches long, projecting out into the airstream at a point along the fuselage.

In operation, the meter indicates the amount of static charge accumulated by the plane in arbitrary units, although it will be ultimately calibrated to indicate volts. Test flights indicate that a voltage lower than 10,000 seldom disturbs radio operation, and



Aircraft static detector, with an electric bulb for size comparison

that peak voltages as high as 1,000,000 are often encountered in extreme static conditions.

Three of these units are in daily service in flight. Some will be placed at ground stations. Pilots will report the readings of the static meter along with other weather conditions when they make their position reports. An important research problem to be tackled is the relationship between the electric charge in cloud particles and the movement of air mass fronts.—*A. K.*

A Master of Aircraft Supercharging Retires

IN these columns we have again and again referred to the aircraft supercharger, without which high-altitude flight is impossible. In no small measure the development of the aircraft supercharger is due to the continued, steadfast, and skilled efforts of Dr. Sanford A. Moss, who is now retiring from the General Electric Company after 34 years of service and 15 years of work on the supercharger. A master of thermodynamics, an ingenious mechanical engineer, Dr. Moss exemplifies the modern scientific engineer at his very best, carrying through a development from its first theoretical conception to the final practical embodiment. Dr. Moss was never a professor but he often showed the absent-minded traits of the professor when on the aviation field. On several occasions in his eagerness to examine the functioning of one of his superchargers he has been pulled away from the propeller blades and well nigh certain death by his associates. In fact, the writer of this column is proud to remember that he rendered the same service to the famous engineer at McCook Field.—*A. K.*

Dr. Sanford A. Moss, pioneer in development of the supercharger

Designing a Sub-Stratosphere Plane

THE Lockheed sub-stratosphere airplane, the *XC-35*, has recently been delivered to the Army, and is making a wonderful record for itself. At an altitude of about 20,000 feet, with its supercharged cabin and supercharged engines behaving splendidly, the *XC-35* reached a top speed of 350 miles per hour over a test course of 220 miles, a distance which was covered in 38 minutes. As can be seen from the photograph, the sub-stratosphere plane is of the low-winged, twin-engined type, with a hemispherical nose and long narrow windows. In other respects it follows conventional modern design.

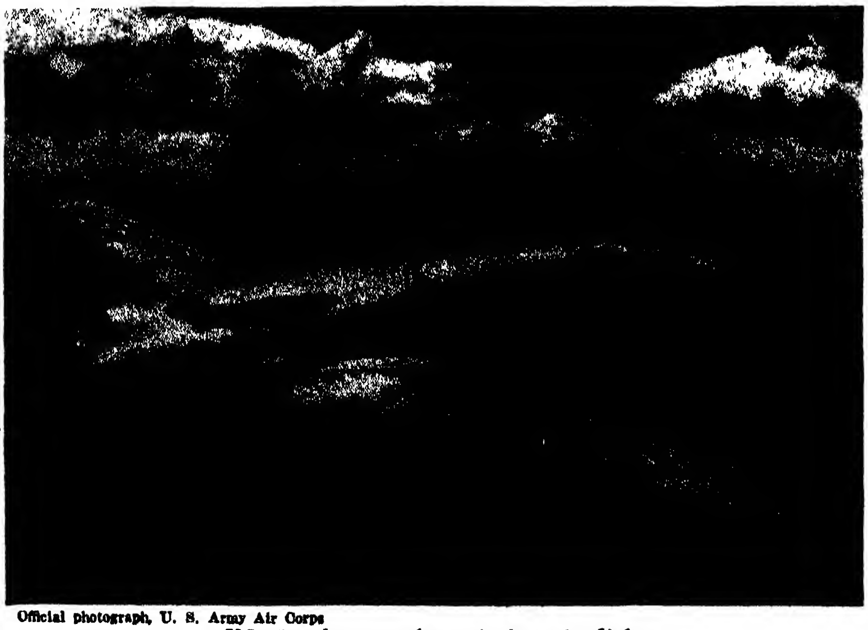
A paper read by Professor Younger at the Annual Meeting of the Aeronautical Sciences deals with the preliminary research work on this ship which was carried out at Wright Field before an order for design and construction was placed with the Lockheed Company. This research work is described in a 250-page report, covering two years of effort; 25 "sub-problems" had to be solved before the design engineers could really get to work.

One of the problems which had to be met from a structural point of view was to keep the fuselage from bursting outwards, since the inside of the cabin is raised to something like atmospheric pressure while the thin air outside may have a pressure of only five to six pounds per square inch. This is best achieved, so theory and tests indicate, by making the fuselage a long cylindrical body with hemispherical ends. For maximum strength the windows should be made rather narrow, of longitudinal strips of glass; the luxury of large, wide windows is not possible in the sub-stratosphere plane. The doors should open inwards; in such a case just a few spring clips will keep them in position since the differential pressure acts to close them. The internal pressure tends to extend the fuselage; the decrease in temperature tends to shorten the fuselage. The two effects counteract each other, but still the fuselage must have incorporated in its structure a certain degree of flexibility to take up these extensions and contractions.

For every passenger about 10 to 20 cubic feet of air per minute must be supplied. While auxiliary engines for the cabin supercharger have been considered, the simplest method is to use the main motor itself as the source of energy for the cabin air compressor. Two entirely independent supercharger systems should be provided.

Many control cables and other leads must pass out from the fuselage. It is very important to lead such cables through oil-sealed passages; to minimize friction the cables slide in brass tubes.

These are but a few of the technical problems which have been successfully met. The complications and weight are far from being as overwhelming as some authorities have expected. Now that the Army Air Corps, together with the Lockheed engineers, has shown the way, there is not the slightest reason why supercharged cabin transports for passenger service should not be readily built.—*A. K.*



Official photograph, U. S. Army Air Corps

***XC-35*, sub-stratosphere airplane, in flight**

"Contentment." This photograph of a Studebaker workman smiling as he guides a flexible sanding belt over the steel surfaces of a truck cab, won an award at an exhibit of the Photographic Association of America at Chicago. It was submitted by Charles I. Center, who won four other awards in the same exhibit with other photographic entries

A Record of Service

MANY years ago, "Soda Ash Johnny" Horan worked out the process, from which his nickname was derived, of using soda ash to dissolve lime deposits in the tubular boilers of wood-burning locomotives. It has saved for his employing road, the C. M. St. P. and Pacific, and other railroads, many thousands of dollars. He could have retired with honor years ago, but scorned a pension in his desire to remain active. On April 17, John M. Horan will celebrate the anniversary of his employment with the same company 83 years ago. He was 100 years old in January, and is now inspector of the boiler

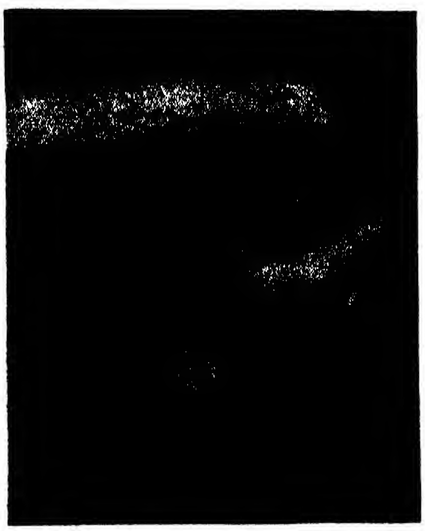
washing department in the Milwaukee shops.

We quote these facts, not to preach a sermon; you may write your own. It would be interesting to know, however, what Soda Ash Johnny would have to say, should someone persuade him to talk, on the subjects of the dignity of human labor, the joy of work for its own sake and, on the other hand, labor relations, strikes and strike-breaking, and government doles for able workers. If he should ever speak his mind on these current topics, it's a safe bet that he wouldn't be very popular thereafter with the "ism" boys.

New Balsam-Wool

LOWER application costs and increasing efficiency are the two outstanding advantages claimed for the new improved Balsam-Wool Sealed Insulation just announced by the Wood Conversion Company. Those advantages are made possible by a new spacer flange along the edges of the insulating mat and a new fibre cleat used to seal the cut edges.

The new flange is scored to fit over the face of the stud, joist, or rafter. It is fastened to the face with a staple hammer. The fibre cleat seals the cut ends at top and bottom edges and where it has been necessary to trim the mat length-wise for narrow openings. Lath is no longer required here.



Applying the new Balsam-Wool

Because the flange controls the position of the Balsam-Wool in construction, important air spaces are assured front and back. The flange, fitting over the face of the stud, assures a tight joint as lath is placed directly over it. As the flange does not completely cover the stud, a guide line is left for lathers. The Balsam-Wool mat is sealed in an asphalt coated moisture barrier both front and back.

Skid Danger Increases with Speed

IMPORTANT findings from an automobile safety standpoint have been revealed as the result of a study of 20,000 tests on skidding tendencies at Ohio State University.

Among the findings are: 1. Regardless of tire tread design, adhesion between road and tires decreases with the speed of the vehicle, reducing resistance to skidding and increasing the difficulty of bringing the car to a stop in an emergency. 2. This effect is most pronounced from a braking standpoint. 3. A light sprinkle causes the average road to be about one third more slippery than a drenching rain. 4. Sliding the wheels of an automobile when applying brakes results in the vehicle traveling much farther before it is brought to a stop. 5. Tires which have been worn smooth may as much as double the tendency for wheels to slide when brakes are applied. 6. Increasing or decreasing tire pressures on ice or in snow does not help traction, as is commonly supposed.

One of the hinged arch bridges discussed below

The tests were conducted under the direction of Professors K. W. Stinson and C. P. Roberts in co-operation with tire companies and highway commissions of several states. In these tests a two-wheel trailer, with a Linderman hydraulic brake on one wheel, was used, the other wheel running free. The trailer was attached to a tow car through a diaphragm connection which translated the effort required to pull the trailer, into hydraulic pressure. The latter, in turn, was recorded on instruments within the tow-car.

The trailer was provided with a gear pump which maintained a constant hydraulic pressure in a tank on the trailer. When ready for a test, the operator in the tow car tripped a switch. This opened a valve on the trailer, permitting liquid to flow gradually through a needle valve into the brake operating diaphragms. These diaphragms are a part of the Linderman brake design, the brake consisting of four floating shoes below each of which there is a diaphragm extending the entire length and width of the shoe. Since the brake is not self-energizing, hydraulic pressure under the shoe is directly proportioned to braking effort.

The brake trailer used in the Ohio State University skid experiments

The use of this installation made it possible to increase braking effort gradually and smoothly until the wheel locked and the tire slid. The amount of pressure (measured by the pull of the trailer) required to do this, is a measure of the "coefficient of friction" between tires while rolling on a road under the specific test conditions.

The pull of the trailer after the wheel locked is, in turn, a measure of the "sliding coefficient" of friction under the same conditions. The sliding friction under all conditions was found to be less than the adhesion with the tire still rolling.

From a car-operating standpoint, the tests would indicate that brakes which lock too easily are a hazard rather than a help, and that adjusting brakes so that the car can be slid to a stop as is the custom in many brake service stations decreases rather than increases driving safety.

Many automotive engineers feel that these tests substantiate the feeling that "self-energization" of brakes should be eliminated, since self-energizing action—while decreasing pedal pressure in modern brakes—has the effect of increasing tendency of wheels to lock and slide.

Unique Hinged Arch Bridges

A UNIQUE method of bridge design, providing speed and economy in construction, as well as beauty of appearance, has been used by the Civilian Conservation Corps in the building of nine bridges in northeastern Illinois park areas. The design was originated by John Taggert, architectural engineer of the central design office of the Forest Preserve District of Cook County, Illinois, and has been approved by the Branch of Engineering of the National Park Service for use in park areas.

The bridges were constructed by CCC enrollees under the technical supervision of the National Park Service which has worked with the county park agencies and the Illinois State Park Department.

The structures are two hinged arches in which the arch ribs are seated in a lubricated socket which is formed in the abutment. The two outer sections of the arch

ribs are precast, each section being a little short of one-half the span. These are centered in the socket and the center section poured in to form the key. The manner in which the socket is formed and lubricated is expected to prevent any excessive frictional stresses during the normal life of the structure.

The bridges were designed specifically for use in park areas developed with foot trails and horse trails over streams and ravines. Because of the comparatively simple design of these bridges, less time is required for their construction and there is also a saving in the expenditure for material. The bridges require, however, absolutely stable abutments, as any movement tends to destroy the hinge action. Bridges of this type are practical only on sites having excellent foundation characteristics.

The majority of the bridges are used by pedestrians, but in some cases carry equestrian and light truck traffic. They range in length from 40 to 90 feet.

A child is held in place by a belt and shoulder straps in this new safety seat for use on either the back or front seat of an automobile

Sewing Machine with Eight Needles

THE last word in efficiency in the manufacture of upholstery is the new Maniplex sewing machine which was built to special order for the Hudson Motor Car Company. It is used for sewing automobile seat cushions.

This machine operates eight needles simultaneously, sewing the braid on four plaits and forming the piping in one continuous operation. Besides the advantage of sewing absolutely straight and parallel plaits (because of the accurate guiding of the cloth made possible by this machine), the job is done in about half the time required by smaller machines and less accurate methods. The new machine requires four operators to feed, cut, and handle the cloth.

GROWTH

IN 1932 Willis H. Carrier predicted that air-conditioning systems in 1948 would require approximately 1,432,000,000 kilowatt hours of electricity. On the basis of the growth since 1932, such systems may need in 1948 actually 8,350,000,000 kilowatt hours.

Colored Insecticides

TO prevent accidental poisoning by mistaking the arsenates of calcium and lead for harmless compounds, the Surgeon General of the Public Health Service has ruled that hereafter all such materials must be given a distinctive pink color. This safety measure, recommended after a careful investigation by the Public Health Service, is being adopted for all insecticides of this type, made for the 1938 crop year, by voluntary agreement of the manufacturers. —*D. H. K.*

Tractor is Fast; Wades, Too

AN innovation in commercial track-laying tractor design recently was seen for the first time by men concerned with road building. The tractor is the newest product of the Marmon-Herrington Company, Inc., engineers and manufacturers of four- and six-wheel motor vehicles with all wheels driving.

The new tractor has attracted widespread interest with its speeds of more than 30 miles an hour, ease of handling, pulling power, quiet operation, and economical performance. Ice, sand, water, snow, and mud are no obstacles to the sensational accomplishments of this new tractor; once on the highway it travels at passenger-car speed without damage to the pavement.

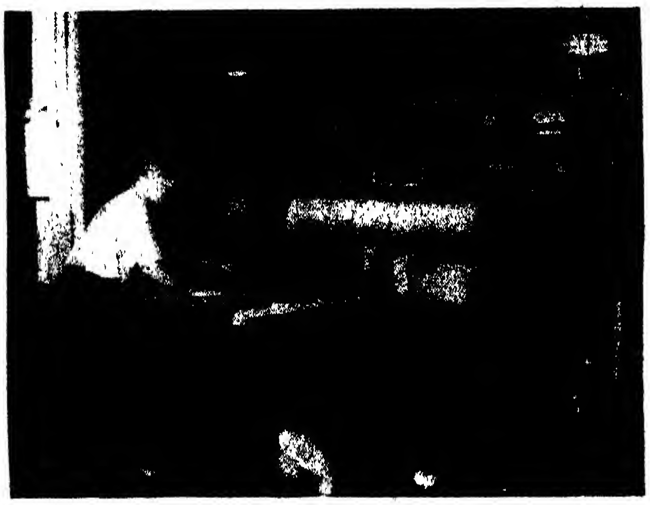
Speed with a track-laying tractor

The new tractor is reported to be the first track-laying vehicle that does not have to be transported to the job by truck or trailer. Its water-tight hull allows it to ford streams of considerable depth. Its specially developed rubber track is said to outwear the conventional all-metal track, and the track will not stretch while providing unusual tractive ability. The unit has a top speed greater than any wheeled tractor and fuel economy of from four to five miles per gallon.

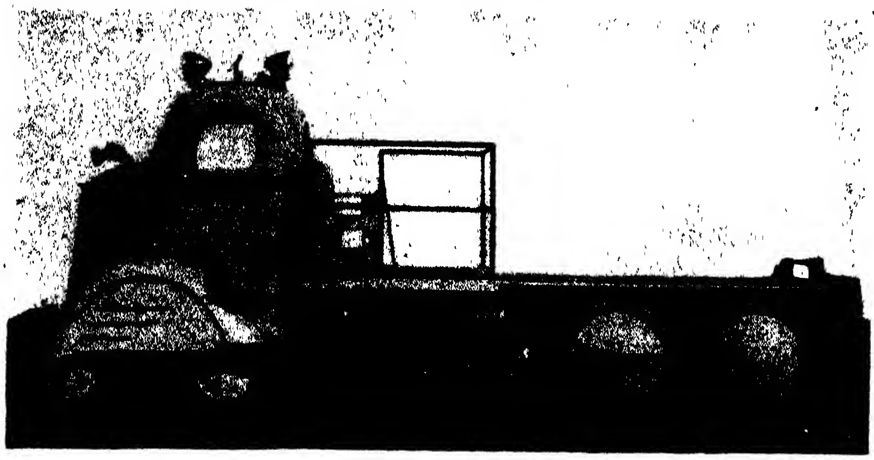
Versatility of the tractor on any terrain under the most difficult conditions in excavation, construction, and maintenance work is its strongest feature.

Bismarck and the Telephone

POSTMASTER General Heinrich von Stephan, the founder of the World Postal Union, always took great interest in the development of the telephone. In October, 1877, he read an article on the subject of Bell's invention in Scientific American. He then immediately ordered one of the Bell telephone instruments. Before this instrument reached him from America, he received as a gift from the Director-in-Chief of the London Central Telegraph Office a complete Bell telephone set. Stephan immediately set to work to dem-



The feed and delivery ends of the eight-needle sewing machine used for stitching automobile upholstery



onstrate the merits of this new discovery in mechanical science. Just 60 years ago, on November 12, 1877, Bismarck, with whom Stephan had corresponded on the subject, consented to have a demonstration of the telephone made at his country seat at Varzin. The new invention impressed the Chancellor favorably, so that it was not long before Emperor William I took an interest, and permitted the telephone to be demonstrated and explained to him.

Rail Truck

CROSS-COUNTRY trucking services nowadays use, within the larger cities, light pickup and delivery trucks to distribute merchandise to and from trucking terminals. At the terminal the merchandise is loaded into large vans for inter-city shipment. The local truckmen get no revenue from the interurban trucker. It is believed that if railroads gave service on the rails comparable with highway service, and made arrangements at each town for local truckmen to pick up and deliver the merchandise, the railroads would have an advantage over the interurban trucker. A new rail truck has been designed for precisely this sort of service.

This new truck, designed and built by Coordinated Transportation, Inc., is to operate entirely on the railroad, never on the highway. It is essentially a highway truck transformed into a rail unit, the transformation being made by incorporating certain patented features together with standard railroad equipment. The truck's front and rear axles, together with their wheel assemblies and the steering gear assembly, are removed, and then a four-wheel-drive rear axle, a four-wheel truck in the front, and high speed reverse transmission and auxiliary radiator are installed. Standard railroad air equipment is added to supply the air brakes of cars that may be pulled.

The patented features of this rail truck consist of the four-wheel-drive rear axle, rubber insulated wheels, and auxiliary radiator. The new rear axle bolts to the rear springs and the drive shaft. The elimination of inner differentials and other gears greatly reduces the loss of power usually experienced in four-wheel drives. The rubber-insulated wheels are made by inserting two circular rubber inserts between the steel tire and steel wheel itself. This insulation absorbs vibration, deadens track noises, and prevents destructive action of steel pounding against steel. The auxiliary radiator is necessary, because the truck has a high-

A four-wheel-drive rear axle is a feature of this rail truck, designed to solve railroad problems. *Right:* Controls in the cab of the truck

speed reverse transmission and can travel as fast in reverse as forward. This radiator makes use of the vacuum created by the moving vehicle to give adequate cooling.

These rail trucks may be powered by either gasoline motors or Diesel engines. Generally speaking, the gasoline motor is more efficient in the smaller units and the Diesel engine in the larger ones. A 1½-ton rail truck can handle one loaded railroad freight car. The larger trucks can handle more loaded railroad freight cars in proportion to their increased power.

Besides their use in a trucking service on rails for branch and secondary lines, these units may prove economical for use in switching and for inspection, repair, and maintenance crews.

A Puzzle Solved, and How

FROM a reader of this magazine, Mr. Norman E. Hills of Kelley's Island, Ohio, a photograph of a conical stone, reproduced on this page, was received some time ago with the following letter:

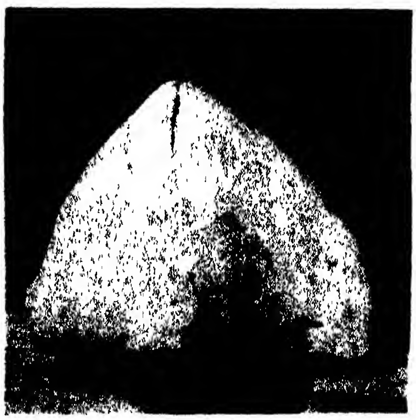
"The fossil of which this is a photograph was found in Devonian limestone in an old quarry at Kelley's Island, Ohio. It is a three-sided pyramid 10 inches in altitude. The sides are smooth but the bottom is uneven, as though, after the flesh of the creature that once occupied the shell had decayed, the base had been filled with different material from that which later filled the remaining space, and which is limestone containing small fossils common to the middle Devonian period. The actual shell has been dissolved. The space surrounding the cast once was occupied by the shell."

The description and photograph were submitted to Dr. Rudolf Ruedeman, State Paleontologist of New York, a specialist on Devonian fossils. The reply received indicated that three other geologists to whom these were shown by Dr. Ruedeman agreed with him that the specimen apparently "is

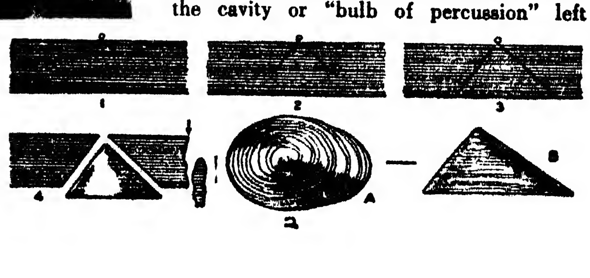
not a fossil and suggests a percussion core such as are found in quarries where a charge has been set off." The reply further stated that such cores had also been picked up in quarries near Albany, New York.

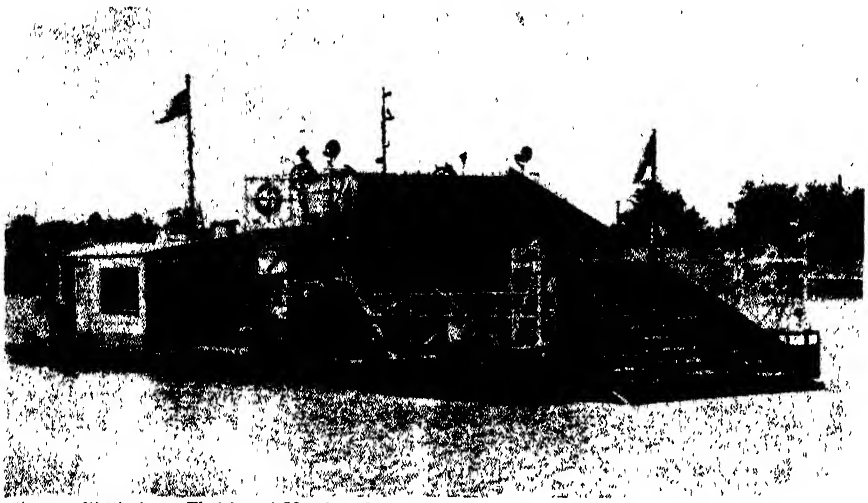
To make clear how a percussion shot in a quarry could make such cores as this, the common experience of workers in flint artifacts such as arrow heads may be drawn upon. If a localized, sharp blow is struck in the middle of a flat piece of flint the stresses are distributed downward and outward, expanding as they go and outlining a conical form. If these stresses are strong enough they may produce a conical fracture whose section is shown in 1 in the accompanying diagram, taken from the illustrated manual of the Stone Age on "Flints," issued by the British Museum. Stronger blows may produce 2 or even 3, in which case a conical piece of the stone drops out, as is shown at 4, also in plan at *A* and in section at *B*. By geologists this is called "conchoidal," meaning shell-shaped, fracture, (incidentally accounting for our Kelley's Island reader's natural assumption that the object he found was a fossil shell of some kind). The same effect is often seen in the glass of windows where a pebble or other round object, striking the glass, sometimes removes a neat core of the same shape but far smaller.

Ordinarily, when seen in glass windows, the cavity or "bulb of percussion" left



A "fossil" that turned out to be something entirely different. The accompanying text tells how these odd-shaped specimens are formed, with particular reference to drawing at the right





Courtesy Westinghouse Electric and Manufacturing Company

A menace to navigation, water hyacinths are destroyed with this equipment

when this has happened measures an inch or less in diameter, but in the stone quarry the blow delivered to the stratum at the level of which the explosive is detonated is sufficiently powerful to spread its fracture downward and outward some distance, making large cores such as the one shown in Mr. Hills' photograph.

When this explanation was submitted to Mr. Hills he was at first inclined to doubt it. However, he soon discovered, on consulting with another person who had found similar objects in the same quarry, that these objects "were found by this man exactly under the hole marks made by the drill for the use of the explosive." In fact, Mr. Hills states that the same person previously had "seemed to think it miraculous that the drill should have stopped just where it did, and that it did not penetrate the (supposed) fossil!" Mr. Hills adds, "I now agree that the solution of Dr. Ruedeman *is* the correct solution, and a more careful examination reveals that some of the fossils at the surface of the core are sheared in the fracture plane, which further corroborates the interpretation given by Dr. Ruedeman."

Photo-Lettering Machine

A NEW mechanical artist that operates photographically has been designed to supply the lithographer, typographer, photoengraver, or printer with a new means for setting up display headlines and small amounts of text which are now laboriously hand lettered or composed from type by hand.

The photo-lettering machine assembles photographic images of letters and composes them into words, giving the effect of fine typesetting or hand-lettering, but using neither type nor pen. In place of type, the photo-lettering machine uses master alphabet plates. These are glass plates of transparent letters which fit into the machine and slide back and forth semi-automatically, bringing one letter after another into focus over a small precision camera. As each letter comes into position, it is photographed instantaneously on film or sensitized paper. All this takes place in daylight where it may easily be seen; in fact, the operator visually controls the mechanism with a layout which he has prepared on the layout spacer, and places the letters precisely where he wants them. When the exposures have been completed, the film or paper is developed.

The machine will expand letters or condense them, stipple them, screen them, overlap them, shade them, or even heavy them. A change of focus gives all sizes from small text to giant headlines with no appreciable loss in sharpness. Justification of lines is automatic; letter-spacing is automatic; borders, backgrounds, trade marks, signatures and repeated designs may be stepped up. This application of the machine is frequently used in preparing all-over patterns such as check tints, backgrounds, and so on.

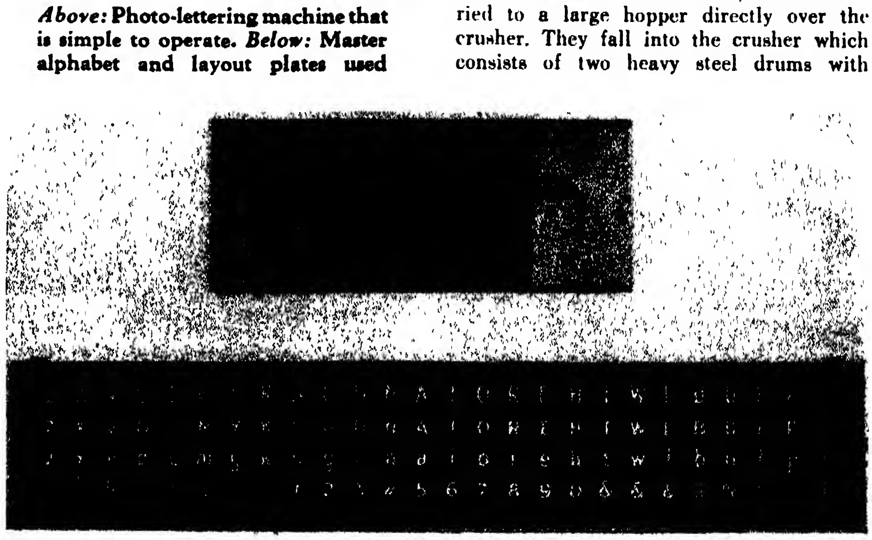
The speed of the machine is not comparable with linotype, but in production of material which would ordinarily be hand-lettered or hand-set, it offers a combination of speed, flexibility, and precision far surpassing all other methods.

The Projection Layout Device, which is included with each Rutherford Photo-Lettering Machine, is a separate piece of equipment and is used for layout work of a special nature.

Operation of the lettering machine requires no particular skill on the part of the operator. Many plants employ boys for this work. An artist, or someone with a knowledge of typography, usually prepares the layout and the operator of the machine has only to select the indicated alphabets and sizes in order to produce quickly the artist's conception of the job.

The range of the machine is from practically zero to 192 point. This range can be obtained with only three different sizes of alphabets.

***Above:* Photo-lettering machine that is simple to operate. *Below:* Master alphabet and layout plates used**



Hyacinth Destroyer

A VERY interesting and unusual installation, though small, using a Diesel electric propulsion system was made recently on a boat designed by the United States Engineer Department, at New Orleans, for the purpose of destroying water hyacinths. These hyacinths infest many of the tributaries and bayous of the Mississippi River and are a serious menace to navigation. For many years the Department has endeavored to control this pest by spraying from special boats, using an arsenic solution. This method is dangerous, not only to the crews of the boats, but to the live stock along the rivers. After considerable effort, the new hyacinth destruction boat *Kenny* was designed and built and is now in operation.

The boat is propelled by twin screws, each driven by a 25-horsepower propelling motor. Power is supplied by two 80-kilowatt Diesel-generating sets. These generators also supply power to a 20-horsepower motor driving a 15-foot wide conveyor at the bow of the vessel, a 50-horsepower motor driving a crusher, a 20-horsepower motor driving a flushing pump and other small auxiliaries.

The boat is propelled slowly through the hyacinth beds and the plants are caught on the inclined conveyor, which extends about two feet below the water line, and are carried to a large hopper directly over the crusher. They fall into the crusher which consists of two heavy steel drums with

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C. M. Chester, *Chairman, General Foods Corp.;* Thomas J. Watson, *President, International Business Machines Corp.;* Alfred P. Sloan, Jr., *Chairman, General Motors Corp.;* Benjamin Rush, *President, Insurance Company of North America;* Frederick W. Pickard, *Vice-President, E. I. duPont de Nemours & Company, Inc.;* Fowler Manning, *President, Air-Conditioning Division American Radiator Corporation;* Robert H. Montgomery, *Lybrand, Ross Brothers & Montgomery;* John G. Lonsdale, *President, Mercantile-Commerce Bank & Trust Co.;* Clifton Slusser, *Vice-President, Goodyear Tire & Rubber Co.;* Samuel W. Reyburn, *Chairman, Board of Directors, Associated Dry Goods Corporation; and many more.*

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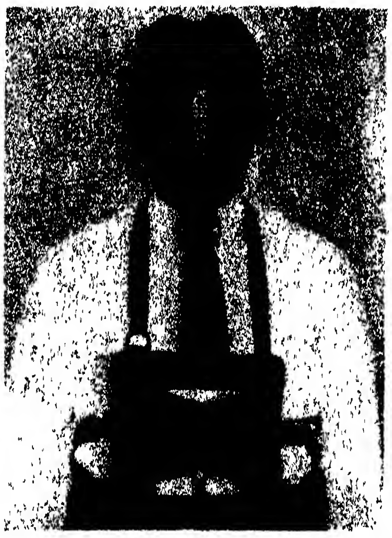
cutters revolving together. After passing through the crusher the material is flushed overboard and sinks to the bottom. If this experimental boat works out satisfactorily, as present operation indicates it will, additional units will be built so that the old method of spraying may be abandoned.

Full Vision Gas Masks

FULL vision lenses, which permit the wearer to see, read, work, walk and observe surroundings in safety, feature the new full vision gas masks manufactured by the Acme Protection Equipment Company, of Pittsburgh. The lenses are made of shatter-



proof laminated polished plate glass and afford 90 degrees vertical and 170 degrees lateral vision.

These new canister masks are available in both corrugated tube and snout types. The light weight, all-rubber face piece is fully molded and cured to master face-fitting proportions. Head harness connections are strategically located to eliminate all forehead pressure points, permitting wearing of hat or helmet without discomfort.

Another feature of this face piece is the elimination of the build-up of used (exhaled) air in the fresh air ducts. This problem is met by employing one-way flap valve ends on the fresh air ducts, which close upon exhalation.

Full vision gas masks are available with a choice of elastic, all-rubber or permanent non-rubber head harnesses and a wide selection of canisters covering organic vapors, acid gases, ammonia, and industrial smokes, hydrocyanic acid, and all known military gases and smokes.

Water Repellent Textiles

TREATMENT of textile fabrics to prevent wetting or staining by water or other liquids has been a serious problem of the textile industry. Lately several new agents for treating cloth have been developed which resist wetting and which do not otherwise change the properties of the fabric. Some of these are based on the incorporation of wax or wax-like materials into the fiber itself and others produce water-repellent surface coatings on the outside of the individual fibers. Such treatments have been developed which are highly resistant to

laundering and dry cleaning. One of the advantages of these treatments is that many stains which ordinarily get on cloth in water solutions (ink, fruit juices, and so on) cannot attach themselves to the fibers after treatment.—*D. H. K.*

Heart Pain Often Due to Overweight

SEVERE chest pain resembling that of the dread heart malady, angina pectoris, is in many cases due to excessive overweight, Dr. William J. Kerr, professor of medicine in the University of California Medical School, has found.

The huge pot belly, or "bay window," of very fat men forces them to adopt an abnormal posture which cramps the chest, causing breathlessness and preventing the heart from getting a normal supply of oxygen. Severe pain and low blood pressure accompany the condition.

The pain and other features clear up when the weight is reduced and the posture brought back to normal, Dr. Kerr found. Diet, exercises, and properly fitted abdominal belts are used in the treatment.—*Science Service.*

DEADLY

DURING 1937 there were delivered to the United States Army 410 airplanes twice as large as their immediate predecessors.

Is Tellurium Light Coming?

LIGHTING engineers have discovered how to change an odor worse than garlic into a light closely resembling sunshine, the *Journal of the Franklin Institute* recently reported.

Three researchers of the Westinghouse Electric & Manufacturing Company's lighting division laboratories reported in the journal the results of a year's experimentation with tellurium vapor as an artificial light source.

Predicting a new lighting system?

Dr. J. W. Marden, Dr. N. C. Beese, and George Meister demonstrated that tellurium, a semi-metallic element which produces a "garlic breath" if inhaled, gives off a continuous spectrum, when incandescent, like

sunlight, instead of a line spectrum as ordinarily found in metallic vapor lamps.

"I don't know what its possibilities are," commented Dr. Marden, "but the idea of duplicating sunlight is a gorgeous thing to dream about and the spectral color distribution from blues through white to yellow may make the tellurium vapor lamp ideal for certain special applications."

Dr. Marden gave tellurium a demonstration workout in an inverted U-shaped bulb equipped with a reservoir containing inert neon gas which is used as a starter. The bulb is made of quartz because glass would not withstand the tremendous temperatures developed in the liquid tellurium and would turn black as a result of the chemical action.

Tungsten wire was used as the external connections of the tube, attached at the two ends of the "U" and completely immersed in the liquid tellurium pools in the bottom of the tube. When the lamp burned brightest the temperature at the electrodes varied between 1300 and 1500 degrees Fahrenheit, two-and-a-half times hotter than molten lead.

Heat is one of the most serious problems that have to be solved before the tellurium vapor lamp can be put to a practical use. "It has been found," Dr. Marden pointed out, "that a very high efficiency will be possible once we find a container that will withstand the chemical action and the heat, and still let the light through. For the present, quartz is the best container we have found."

Like many developments of the research laboratory, the tellurium vapor lamp has arrived before the practical demand has materialized. But, as Dr. Marden commented: "It's our business to pry into every type of discharge we can imagine as a source of light."

For the time being, the new lamp will remain a laboratory curiosity, but it is another step forward in man's search for the best light.

DIRECTORIES

NEW YORK CITY'S five alphabetical phone directories, of which more than 1,500,000 copies are distributed in the city, would fill a book shelf 50 miles long.

ELECTRO-PLATED PLASTICS

BY a new process of electroplating, developed in England, metals may be deposited on molded plastic articles to produce decorative or protective effects. Copper, brass, nickel, chromium, silver, and rhodium have been successfully applied. The process supplements that of molding the plastic around a metal core or skeleton as now practiced to give the finished article strength greater than that of the plastic alone.

The combination of metals with the many colors available in modern plastics places at the disposal of the molder and fabricator an entire new range of decorative effects. With metals varying in color from copper and brass to silver and chromium can be combined the many colors of clear and translucent plastics to give effects heretofore

impossible. The new method permits depositing the selected metal on any desired parts of the molded article.

Aside from decorative possibilities, the electroplating of metals suggests the use of the new technique as a protection for plastics under conditions which might otherwise destroy them. Alkali resistance is imparted by nickel plating and both rhodium and chromium resist solutions containing salts and some acids. It is thus possible to line containers molded of plastics with metals which resist corrosive action of their contents, when that is necessary.

The new finish permits many articles to be made of plastics of light weight which hitherto have been die cast.—*D. H. K.*

TAXES

FORTY cents of the motorist's tax dollar is spent on highways, 25 cents is allocated to local units, 16 cents is diverted to non-highway uses, 14 cents goes for payment on debts, 4 cents for collection and administration expense, and 1 cent for state police.

Air Conditioning Cuts Employee Loss By Reducing Sickness

LOSS of employee's services from colds and other respiratory illnesses has been cut from an average of 2.2 days to 1.6 days during the past year in the air-conditioned offices of Procter and Gamble Company, manufacturers of soaps and allied products.

This company occupies five floors of the Gwynne Building, 13-story Carrier air-conditioned structure in Cincinnati. The soap manufacturers were the first to install air conditioning, their success with it leading to the complete building installation.

Luminescent Paint

NON-TOXIC, non-flammable luminescent paint which contains no radioactive material is now on the market. The principal constituent is calcium sulfide which, when exposed to light, subsequently glows in the dark. This paint can be applied to metal, glass, cloth, paper, wood, and almost any other common material.—*D. H. K.*

Electric Eyes Protect Human Eyes

REALIZING the vital part played by adequate and uniform illumination in any work requiring close concentration and mental effort, General Electric engineers have devised an inexpensive photo-electric lighting control that keeps the light in a room or building at the proper level for satisfactory work.

Fatigue and poor work because of eyestrain can easily be eliminated when sufficient light is provided. Persons working in a room where automatic lighting control is installed are free to go about their work without being interrupted or annoyed by poor light. When artificial light is needed to keep the illumination at a pre-determined level, the lights are turned on automatically.

When enough natural light is available to provide this amount of illumination, the artificial light is turned off.

This desirable control of the lighting in a room is accomplished by means of a phototube, or "electric eye," application. A phototube is set up so that the natural light coming through the windows falls on the tube. Any difference in the amount of light striking the tube causes a change in the amount of current flowing in the tube. This current change is amplified by a standard radio tube so that it is of sufficient magnitude to operate a relay which in turn operates the lights.

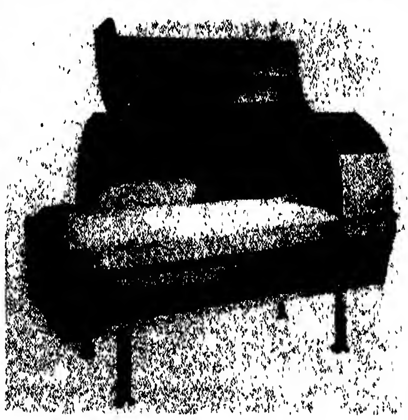
New Letters for Movie Titling

Letters cut from sponge rubber 3/16 of an inch thick, painted either silver or black on their faces, and having an adhesive back which never wears out have just been placed on the market for use in composing titles for movies or still pictures. The letters are deep-cut block letters in two sizes—1 inch and 1½ inches tall. They may be pressed into position on any smooth surface, the adhesive gripping firmly. They are as easily removed and used again in another set-up.

For titling amateur movies or still photographs these letters may be mounted on translucent glass panels to give interesting effects with back lighting, or may be side-lighted to give an exceptionally strong relief effect. These Spell-O-Tex letters are made by Besbee Products Corporation and distributed through most of the leading photographic supply houses.

Stainless Steel Health Bath

Stainless steel is filling another need in medical equipment—this time for the cabinets of electric steam vapor baths, used in the treatment of human ailments requiring moist or dry heat. Applications of steam



Health baths are given in a reclining position in this new cabinet

vapor, including oil, menthol and sulfur mixtures, may be given to patients while they are in a reclining position.

The new cabinet is manufactured by the Electric Hotpack Company, Inc. Twenty-two-gage Armco 18-8 stainless steel, manufactured by The American Rolling Mill Company, is used for the entire covering. During two years of experiments, it was found that stainless steel was the only metal

that met all of the requirements for this new product.

Special features included in the new type of cabinet are thermostatic heat control, automatic water control, automatic steam control, built-in showers for hot and cold water, and infra-red ray units.

The machine is used for artificial fever, pneumonia, high colonic irrigations, flesh reducing, neuritis, rheumatism, infantile paralysis, asthma, high and low blood pressures, sprains, fractures, breaks, and general health baths.

Pocket Letter Scales

It is always embarrassing to mail letters or packets and have the recipient pay additional postage merely because we guessed the weight. Manufacturers of new pocket

Convenience in letter weighing

scales had this in mind in developing this handy little device in a size that busy executives, salesmen, and travelers can carry in their vest pockets. These scales, developed by the Autopoint Company and called Postalett, will weigh letters or packages from half ounce to half pound. The accompanying illustration indicates that it is as simple to use as is the fisherman's spring balance.

Elements Beyond No. 92

If you look in any chemistry text book that is not just fresh off the presses, you will find a table of the chemical elements that ends at uranium, number 92. That is the way the chemical elements, building stones of everything around us, were first arranged back in 1871 by Mendeleeff, the Russian, and Meyer, the German, to form the periodic table.

There was no place for elements heavier than uranium, the 92nd. Yet science has discovered not one but at least four such "trans-uranic" elements. Little wonder they were not discovered earlier, for the discovery was dependent upon creating them first and this was done only through the use of the neutrons, discovered in 1932, to produce artificial or induced radioactivity, a possibility first realized only as recently as 1934.

Prof. Enrico Fermi of Rome was the first to make one of these super-heavy elements by bombarding uranium with neutrons. Uranium is the radioactive parent of a whole family of lesser elements and its fame comes from its natural and constant disintegration. But under neutron bombardment, occasionally one or more of the neutrons

sticks, in effect, in the heart of the uranium atom. The uranium is transmuted into a heavier element.

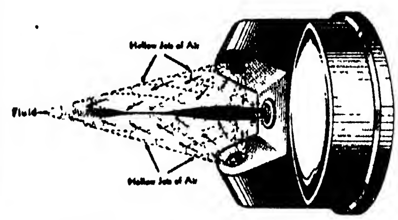
All of the newly-made elements are very short-lived. They break down radioactively, but they disintegrate much faster than radium. Half of the quantity is changed (what the physicist calls the half-life period) in 16 minutes for the most fleeting to three days for the most stable.

With such short lives, it is little wonder that the elements beyond 92 do not exist naturally. When the earth was very young and freshly carved from the sun, it may have had these elements which have long since disintegrated.—*Science Service.*

"Hollow-Air" Atomizer Head

TODAY more and more paint and enameling jobs are being done with spray guns. There are, however, some synthetic enamels, lacquers, and paints which are very difficult to atomize and yet must be applied with a uniform width and smoothness in order to avoid sagging and "orange peeling."

A new atomizer head which has two impinging jets of "hollow air" instead of the solid jets heretofore used in paint spray



How the new atomizer works

guns, is said to be capable of atomizing the more difficult materials and to prevent the defects so common with ordinary spray guns. This new device, made by the Alexander Milburn Company, operates with the usual air pressure and siphon or force feed. The jet of liquid blown from a central orifice passes between and is atomized by two rotating jets of air which face each other from opposite sides of the central orifice. It is said to enable the operator to apply synthetic paints with a fan spray of uniform width, without splitting, giving good atomization between extremely wide limits. Working with the gun at the normal distance of six to ten inches from the work, satisfactory spray widths of 18 inches or more are obtained.

Radio Waves Kill Insect Pests

HAVING recently received from an Italian Government bureau request for further information on the article carrying the above title which was published in our May, 1933, issue we asked the author of that article, Mr. J. H. Davis, of the Baltimore and Ohio Railroad Company, the present status of the work in this field. It will be recalled that the article pointed out that considerable success had been achieved in the destruction of all insect life and insect eggs in shipments of grain by subjecting the grain to short wavelengths. Mr. Davis has answered, in part, as follows:

"Since the publication of my article in

Scientific American, we have continued our research work with special reference to the study of the effects on many kinds of seed irradiated by high-powered short radio waves and have found that under proper exposure as to field strength and wavelength, seeds so irradiated show enhanced germination, growth, and yield properties.

"In the case of wheat seeds with which one of the leading universities has been experimenting for about 44 years, the increased yield compared to the control samples showed an 8.5 percent increase where exposed to 42 megacycles and a field strength of about 2000 volts per lineal inch for a period of eight to ten seconds."

Bendable Tire Valve

A NEW valve for motor-car inner tubes may be single bent to any desired angle to fit any type of automobile wheel. The valve insert is made of special metal tubing that will always assure correct hand bending and will not close the air passage. The base of the valve is prepared for vulcanization to the tube and it may be bent before or after it has been applied. This item, developed by A. Schrader's Son, offers a big advantage to dealers, eliminating the necessity of stocking several styles of angle valves.

A versatile tire valve

Spray Drying Produces Tiny Bubbles of Milk, Eggs, or Soap

THE new methods of spray drying, which are used for milk, eggs, soap, potato flour, or blood, were described recently at the 4th Chemical Engineering Symposium held at Pennsylvania University.

If you have ever used any of these dried products, you may have noticed that they may come in the form of tiny, solid bubbles which are light and hollow. It is spray drying which produces this unusual form. Additional solubility attained when one wants to put the dried product back into an edible or usable form is a merit of the method.

Ben B. Fogler and Robert V. Kleinschmidt of Arthur D. Little, Inc., described new techniques. It takes only from 15 to 30 seconds for little liquid bubbles of the material to be dried into solid spheres, they indicated. Great towers, sometimes two stories high, are employed. The sprayed solution comes in the top of the tower and drops by gravity during the drying.—*Science Service.*

CAMERA ANGLES

Conducted by **JACOB DESCHIN**

Exercise in Lighting

THE problem consists in illuminating a still life comprising three pieces of glazed earthenware—two "glasses" and a carafe. Among the difficulties to be overcome are the facts that the body of the carafe is very rounded and has a relatively small base, the glaze introduces the problem of reflections, and the proximity of one of the glasses to the carafe as well as the rotundity of the latter necessitates a lighting scheme that will result in a minimum of shadow areas.

Because we want tonality, we start with a single light shot at an angle, as in Figure 1. But we find this unsatisfactory and at once abandon the angle altogether. So we make another lighting start, this time from overhead (Figure 2). The result is vastly improved; we are particularly attracted by the interesting surface appearance of the glasses. The shadows must, of course, be "filled" in and other illumination brought in to model the roundness of the subjects. Being in an experimental mood, we temporarily suspend this scheme and try something else.

In Figure 3, we finally employ two illuminants, this being inevitable from the nature of the subject. One is placed directly in front, that is, alongside the camera, the other is directed from the side of the subject downward at a 45-degree angle in relation to the base of the set-up. Shadows are filled in, everything is lighted, but depth and roundness are lacking and pictorial interest is low. By substituting the top light (Figure 2) for the frontal light, we find that at last we are getting somewhere.

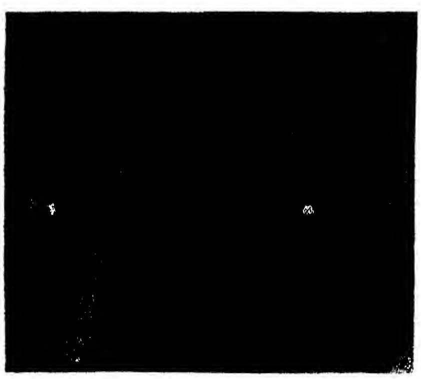


Figure 1

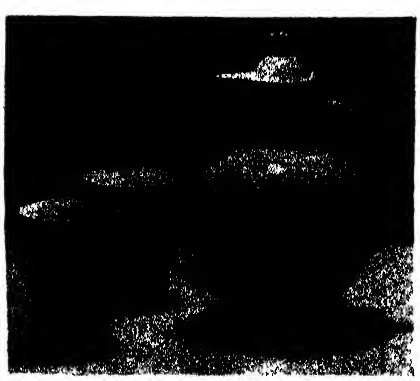


Figure 2

Figure 3

Figure 4

Thus, in Figure 4 we have what we believe might be the basis for the final picture. The only thing left to do to complete the job is to light the shadows. But we must do so without endangering the tonal range of the subject-matter. A third illuminant, or reflecting surface, is found necessary, but it must be carefully controlled and directed. It should, as nearly as possible, permit the retention of the interesting surfaces on the glasses that pleased us so much in Figure 2.

However, the use of three lights introduces grave difficulties, so we try again to get the proper result through the use of only two lights. We are loath to abandon the top light. Is not there something that can be done to make this light provide better illumination? We leave the top light where it is, but move the set-up closer to the background, thus bringing the top light a little distance forward of the subject instead of directly overhead. The glasses lose a bit of their attraction under the scheme

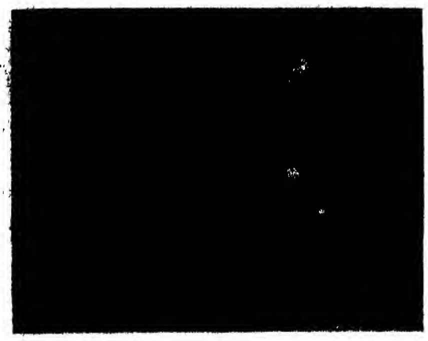


Figure 5

illustrated in Figure 2, but the carafe is better lighted. This is compromise Number 1.

It now appears that if we are to use only one other light, this must come from the front. Recalling the results obtained with a frontal lighting in Figure 3, we know we have a job ahead. First, we employ a weaker light than that used in Figure 3; also, we set the light back a little. But the light reaches the glasses as well as the carafe, and this is not what we want. So we "blink" the left half of the light to prevent the full strength of the light from reaching the glasses. This is compromise Number 2.

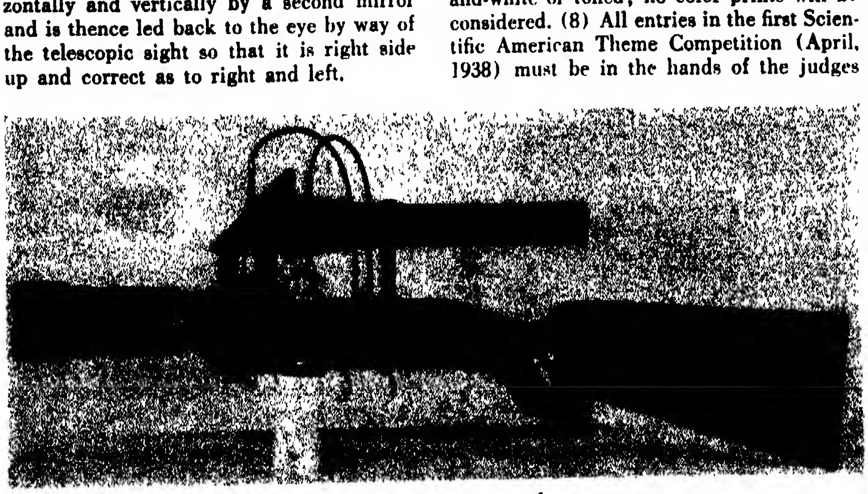
A third compromise was included in the enlargement of the negative, namely, a little dodging at the two ends of the carafe base. This was necessary because the light naturally did not reach these points in an intensity strong enough to survive the printing time required for correctly rendering the tones of the negative.

Thus, by a series of try-it-and-see lightings, we finally achieve a picture (Figure 5) that we believe is a fairly correct rendering of the subject-matter photographed. If we have had to make a compromise here and there, it is only because light, after all, will not do everything.

The Leica Camera Gun

SHOOTING pictures at long range is facilitated for the sportsman, naturalist, and news cameraman by the recently introduced Leica Gun, which includes the Leitz 200 mm Telyt lens mounted on a Leica camera and the whole supported by a gun stock which takes the place of a tripod. A telescopic sight is incorporated for focusing on the ground glass of the mirror reflex housing, focusing being done by means of the lens barrel. The image is corrected horizontally and vertically by a second mirror and is thence led back to the eye by way of the telescopic sight so that it is right side up and correct as to right and left.

The Leica Gun is a rapid action gun by reason of the pistol grip and the two triggers, the latter being arranged in a natural position for the fingers. The forward trigger releases the shutter, thus making the exposure, while the rear trigger, which is connected to the camera take-up by means of a rachet, winds the shutter and brings a fresh section of film into place. The complete gun weighs 8¾ pounds, assuring steadiness when held at shoulder level.



A gun for shooting pictures at long range

Theme Competition

STARTING this month and continuing until further notice, this department offers its readers an opportunity to win prizes by competing in a fascinating phase of the art of photography. Each month there will be given a definite assignment in interpretive photography, to be fulfilled according to each individual photographer's own imagination or artistic ability. Prints submitted in these monthly competitions will be judged on the interpretation of a theme, as well as on pictorial appeal and technical excellence. Each month two cash prizes—$10 for the first prize and $5 for second prize—will be awarded, and there will be two honorable mentions, each to be a year's new or extension subscription to Scientific American.

The simple rules of the contest are as follows: (1) All prints submitted must be mounted, the over-all size *of the mounting* not to exceed 11 by 14 inches. Prints may be any size from 3¼ by 4¼ inches up to the maximum area of the mount. (2) Not more than one print may be submitted by each contestant, it being left up to him to judge his own work, and to select the one which, in his opinion, best portrays the theme of the assignment. (3) Prints may be forwarded by any means desired but each must be accompanied by the required return postage. (4) No names or titles are to be placed on the face of the photograph; on the back of the mounting must be given the contestant's name and address, together with the name of the camera and of the film employed. (5) The competition will be judged by the conductor of this column and the editorial staff of Scientific American. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants. Prize-winning photographs will become the property of Scientific American to be used in any manner at the discretion of the publisher. (6) No entries will be considered from professional photographers. (7) Prints may be black-and-white or toned; no color prints will be considered. (8) All entries in the first Scientific American Theme Competition (April, 1938) must be in the hands of the judges

by May 1, 1938. The results will be announced in our issue dated July 1938. (9) This competition is open to all amateur photographers who are not in the employ of Scientific American.

APRIL COMPETITION THEME: "REPOSE"

The assignment for the first competition is "Repose." In this case, the interpretation of the theme might involve the placid surface of a lake at sunset, a bather at ease on the beach, a dog or cat curled up in a corner, hands in a relaxed pose, a child asleep in its high-chair, or 101 other things that the active mind of the resourceful photographer will suggest. These hints are thrown out at random and are not necessarily to be considered as definite suggestions.

Address all entries: "Repose" Competition, Photograph Editor, Scientific American, 24 West 40th Street, New York, N. Y.

Here is something well worth shooting at, both to test your sense of photographic interpretation in competition with others, and because of the prizes involved. Go to it!

Watch for the second assignment next month.

WATER "MOTOR" REVOLVES REEL

CONTINUOUS replenishment of the fresh-water supply in washing miniature negative strips in a developing tank is provided by the method illustrated here. The water is sent in a long stream through a length of rubber tubing suitably poised to

For better washing of films

reach the opened tank at the required angle. The tank is so placed that the "point of impact" between water and tank is along the edge of the tank, rather than against the reel itself. When thus arranged, the force of the stream of water not only assures a continuous change but at the same time revolves the reel, resulting in a more thorough washing within a relatively shorter time than would be required without this ceaseless agitation.

ROLLEIFLEX CONTEST

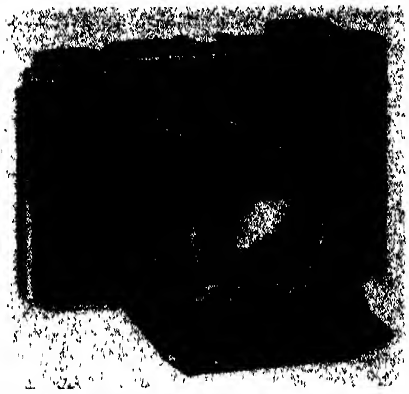
A TOTAL of 450 dollars in 31 cash prizes is to be awarded for entries in the Third Rolleicord-Rolleiflex Salon to be held May 2 to 8 at Rockefeller Center, New York City, under the sponsorship of Burleigh Brooks, Inc. Last day for receiving entries is April 16. Any United States resident using the Rolleicord, Rolleiflex, Heidoscope, or Rolleidoscope cameras may submit up to a total of four prints. The salon is to be divided into two groups: Pictorial and News and Technical. First prize in each group is 75 dollars. Rules provide that prints must be

at least 7 by 7 inches, mounted in such a way that the overall size does not exceed 16 by 20 inches; name and address, exposure and printing data must be pasted or written on back of each mount and return postage must be enclosed. The judges will be: Adolf Fassbender, F.R.P.S., Margaret Bourke-White, and Herbert C. McKay, F.R.P.S.

New Super Ikonta B

Range finder and view finder are combined in a single large finder, permitting finding and focusing in a single operation, a feature borrowed from the Contax, in the new model of the Super Ikonta B, recently announced by Carl Zeiss, Inc.

The Super Ikonta B takes eleven 2¼ by 2¼-inch pictures on 120 or B-2 rollfilm, is



Range- and view-finder are combined

equipped with the popular Zeiss Tessar F:2.8 lens in a Compur Rapid shutter with speeds up to 1/400th second, delayed action device, exposure counter, device for preventing accidental double exposures, two-point setting for use as a fixed focus camera.

Fotofolio for Mini Negatives

The Fotofolio book-type method of filing prints and negatives has been made available to the minicamera fan in the "Miniature" Fotofolio, which will take 288 strips of prints and negatives, or a total of 1728 35-mm prints and 1728 negatives per volume. Photographs and negatives in strips of six frames each are accommodated by the volume, which consists of eight pages, each of which is equipped with attached gummed cloth strip hinges to take 36 strips of prints. The hinges are equipped with envelopes, one for each series of six hinges, each envelope holding six negative strips. Non-scratching paper protects the negatives.

Photographic Exposition

Characterized as "the most comprehensive exhibition of photographs and photographic and allied equipment ever held," the First International Photographic Exposition is scheduled to be held at Grand Central Palace, New York City, from April 18 to 24, inclusive.

The exposition is to have five main divisions: an all-inclusive international exhibition of photographs under the personal supervision of Willard D. Morgan, Contributions Editor of *Life;* stage show and picture-taking free-for-all, dancing, fashion shows, athletic events and other attractions to be

presented chiefly for the purpose of offering picture opportunities to candid camera enthusiasts; two lecture and demonstration halls, in which a comprehensive program of lectures and demonstrations will be presented by leaders in their fields and where information will be available on various photographic problems; complete manufacturers' exhibition section; and a retail dealer section.

The executive committee of the exposition comprises Joseph Dombroff, president of The National Photographic Dealers Association, Inc.; Henry Herbert, president of The Guild of Photographic Dealers of New York, Inc.; H. O. Bodine, president of the Photographic Expositions, Inc.; A. J. Powers, honorary member, International Photo Engravers' Union, and Col. Roy W. Winton, managing director of Amateur Cinema League, Inc.

Mask Your Negatives

Where the negative holder of the glass "book" type is used for negatives smaller than the size for which it was designed, some amateurs, through carelessness or laziness, sometimes prefer not to go to the trouble to mask the negative. As a result, the light coming through the negative from the enlarger light-source comes uselessly—and harmfully—through the clear glass area as well. Uselessly, because in this way it serves no purpose at all; harmfully because it fogs the paper to a certain extent. Try an experiment sometime and see the vastly different results obtainable with a masked negative and an unmasked negative enclosed in a holder larger than the negative used.

Vest Pocket Tripod

Believed to be the most compact tripod extant, the Roll-O-Pod, which is shaped like a smooth round box, three inches in diameter and one and a half inches high, is now being distributed by the Intercontinental Marketing Corporation. Although fitting the vest pocket, the Roll-O-Pod stands 40 inches high and is said to be capable of supporting a fairly heavy camera. The tripod has a built-in swivel tilt top. The casing of moulded Bakelite acts as the tripod head when the Roll-O-Pod is set up. Each leg consists of one strip of high grade Swedish steel, entirely rigid when set up, yet of such cross-section that it rolls up easily inside the Bakelite casing.

Freak Film Fogging

A curious misfortune befell a photographer of our acquaintance recently in airmailing some color plates from California to New York. It so happened that the same plane was carrying a consignment of radium and as a result the exposed 8 by 10 color plates were somewhat fogged. On returning to New York, you can imagine his dismay; fortunately he was able to rescue enough from the wreckage to save the day.

Precis 44 Enlarger

Certainly nothing could be more indicative of the unabated interest in miniature photography than the great influx of new enlargers on the market. There is plenty of stiff competition and any enlarger

that expects to survive has got to be good.

The latest stalwart in the field is the Precis 44 Enlarger, which has been introduced by the Raygram Corporation. One of its principal features is a metal-glass combination pressure negative holder taking negatives up to 4 by 4 cm. Some of the other specifications are as follows:

". . . taking negatives to 4 x 4 cm"

Enlargements up to 9 by 14 inches; single 2½-inch condenser system; baseboard, 16 by 15¾ inches, of seasoned plywood, polished, balanced by rubber legs; preliminary focusing by friction wheel on 27-inch vertical post, critical focusing by turning helical oversized tube in which lens is mounted; red filter attached to focusing gear post.

The Click in Time

Recalling the advice of writers that the photographic journalist should never venture forth without a camera somewhere on his person in anticipation of the chance shot that comes once in a life-time—or so—the Leitz company quotes the experience of a New York amateur, Victor D. Solow, in this connection:

"While going about his accustomed tasks where he is employed, he was electrified at the news that an upper story window had fallen from a building across the street and had hit several pedestrians. Solow grabbed his camera, rushed to the street, made pictures of the men awaiting the ambulance and, after its arrival, pictures of them being treated at the scene. To complete the series he made a close-up of the broken window casement.

"Solow then called the New York *Daily News*, which immediately dispatched a messenger to secure the pictures. So excellent and dramatic were the shots Solow had made that three of them were reproduced."

YOUR QUESTIONS ANSWERED
A New Service for Amateur Photographers
See Next Page

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

***Q.* I seem to be having trouble with glossy prints lately. I enclose two recent examples of what I mean. Will you please tell me what is wrong?—H. J. K.**

A. Both prints indicate the following faults: The print surfaces did not make complete contact with the ferrotype tin; the surface of the tin is scratched; the tin was not cleaned before laying the print down. For best results in ferrotyping glossy prints, the glazed surface of the tin must be thoroughly cleaned before use by wiping with a clean cloth and then treating with a thin coating of ferrotype polish, procurable in any photographic store. Apply the polish with a wad of cotton and rub over the entire surface with a circular motion first to apply the polish, then, with another wad of cotton, "rub it down" so that when the job is finished the polish appears to have been rubbed off altogether. In placing the print on the tin, make sure the print makes a firm contact with the glazed surface, exerting sufficient pressure on the roller or squeegee to insure that there are no slight bulges where the surfaces of print and tin do not meet. This is the cause of the unglazed circles in your prints. If slight bulges do appear, rub them down with the fingers and apply the roller or squeegee once more. Nothing can be done for scratched tins. Because of their delicate surface, the tins should not be stored just any old way, but should be covered with soft paper or protected in some other way when not in use.

***Q.* Can you suggest a method of labeling solution bottles so that the labels will stay put despite frequent subjection to water?—P. R.**

A. Write your legend on the label, paste the latter on the bottle in the usual way and then brush the label with varnish, the latter thus furnishing a sort of "glass" covering.

***Q.* What is the slowest shutter speed it is safe to use when shooting hand-held exposures with a miniature camera?—J. K.**

A. One man we know says he never makes snapshots from the hand at less than 1/100th of a second because he wants to be dead sure his miniature negatives come out knife sharp. He went so far as to add that even for 1/50th he uses a tripod. Personally, we feel he is over-zealous but there is no denying the logic back of what he says. Miniature negatives often are enlarged 10 diameters and more; for a negative to stand that much magnification it *has* to be sharp. What is the use of taking the pains to get sharp focus when you don't give the camera a chance to stay rigidly "put" during the short interval of the exposure? However, most persons can hold the camera steadily for 1/25th of a second, though 1/50th is better. Some shoot at 1/10th and get away with it. Since your question intimates that you seem to be having some trouble in this connection, we suggest the following personal experiment: Focus on some object that is brightly illuminated either with sunlight or artificial light. When you have made absolutely certain that you could not possibly focus the object with greater accuracy, make three or four exposures each at 1/25th and 1/50th and possibly one or two at 1/100th of a second. When you have finished processing the negatives, enlarge all the negatives to the limit of your enlarger's capacity, being careful to identify negative with print (this can be done by marking the back of the print with pencil before immersing it in the developing bath). When the prints have dried, study each one under a magnifying glass. That will tell the story. While you may shoot sharp once by accident you won't do it four times in succession. If you find the 1/50th prints are sharper in practically every case than the 1/25th ones, by all means adopt 1/50th as your minimum for hand-held snapshots.

***Q.* What is the easiest, yet reliable, method to determine the definition of a used lens after it is mounted in a camera body?—J. L.**

A. The real test of a lens is in its performance. Some impression of the quality of the lens may be gained from ground-glass inspection of the image that comes through it, but even if you were to use a magnifier for this purpose, the story would be incomplete until you had actually made some shots with the lens in question and inspected the negatives.

***Q.* I plan to make a visit to Europe this summer and hope to take some pictures during my sojourn. I have heard that Scheiner film ratings there are somewhat higher for the same film than the ratings in the United States. Will you set me straight on this?—V. A.**

A. If you take your film supply with you, as well as an exposure meter purchased in

this country, you will, of course, have no trouble in this regard. However, there is always the likelihood that while you may bring your own meter your film supply may run out and you will be obliged to purchase film abroad. It is known that identical film is rated 5 to 6 points Scheiner higher abroad than it is here. Thus, film rated 23 degrees here may be rated 29 in Europe. This has given rise to the use of two Scheiner classifications, the U. S. Scheiner and European Scheiner. European meters are calibrated for the European Scheiner system, while meters sold in this country are calibrated for the U. S. Scheiner ratings. Therefore, if you purchase a 29-degree film while in Europe, your American-bought meter should be set for 23, or a compensating allowance made on your lens diaphragm, opening the iris two stops wider than called for by the meter reading for 29 degrees.

***Q.* Is there any saving to be gained in purchasing large sheets of photographic paper and cutting them down to desired smaller sizes?—H. V. A.**

A. Not enough to make it worth while. For example, if you wanted to make 5 by 7 prints and purchased 11 by 14 paper to get four from each sheet, you would, according to one catalogue, be saving only a nickel.

***Q.* How does one go about submitting pictures to a photographic exhibition? —J. L. G.**

A. It's the easiest thing in the world. The hardest part lies in selecting the four prints you think best merit the honor of salon exhibition; you are the first judge. Most contemporary photographic exhibition rules limit to a total of four the number of prints that may be submitted by any one contributor; require that prints be mounted on the standard 16-by-20-inch mounts, although the prints themselves may be much smaller (11 by 14 prints are generally favored by exhibitors); require a fee of 50 cents or one dollar to cover incidental expenses, such as the return of prints; and publish a closing date for the receipt of prints. It is important that the prints be carefully packed so that the package may not be bent or the corners of the mounts damaged. At the conclusion of the exhibition, prints are returned in the same package in which they were received. Specific rules concerning particular exhibitions may be obtained from the secretary of the society sponsoring the exhibition. Not all submitted prints are accepted, of course, but acceptance is generally held to be a mark of excellence and therefore a proof of good craftsmanship.

***Q.* Will you please advise me whether it is absolutely necessary for one to take a formal course in photography in order to get a complete training in this field? I would like to study photomicrography in particular and would like to know if any school offers a course in this work and whether this field is a paying one.—Miss P. McD.**

A. It is quite possible to become a professional photographer without taking a course, but the process takes much longer; since you say you have only spare time to devote to it at present, we should think that a practical course would be advisable. Any field in photography can be made a paying one, provided the photographer can introduce new ideas. This is especially true of photomicrography which has been found profitable by workers in your own field of medicine. We do not know of any course being devoted exclusively to the field in which you are interested, though we are sure that if you were to consult some reliable school, special instruction in this type of photographic work could be made available to you. Of course, all phases of photography are interrelated and a knowledge of the fundamentals is essential to the understanding of any specific field.

***Q.* This summer I expect to take a Mediterranean cruise and hope to do some photography, especially in Egypt. I understand that the lighting conditions in Egypt make for poor pictures with thin sky. What I want to know is: Can I use a light red filter and work without a tripod or would you recommend a different filter?—Dr. F. G. W. G.**

A. The use of a light red filter will, of course, give you a rather dark sky. You may not always want this effect; often it is better for the general spirit of the picture to have a lighter sky and still have the clouds stand out. As to the use of a tripod, this can be dispensed with if you find it possible to open the lens wider to compensate sufficiently for the increase in exposure that would otherwise be necessary with the filter used. Offhand, we should say that a tripod would not ordinarily be necessary if this method were adopted; sometimes, however, you may not be able to get sufficient depth of field unless you stop down the lens. In that case you will probably have to use a tripod. After all, you doubtless will take one along with you anyway, even if only for the possibility of night picture-taking. There are several light-weight, compact tripods on the market that would not be too much of a burden to pack or to carry.

***Q.* The lens apertures on my camera are marked 1, 2, 4, 8, and so on. Can you give me the F: value equivalents? —A. B.**

A. Your diaphragm scale is marked according to the so-called U. S. (Uniform System) scale. In converting these designations into the more widely used F: system, wherein the indicated F: value is a fraction of the focal length of the lens, computations begin at F:4, which is equivalent to U. S. 1. Thereafter, each numerical doubling of the F: value is equivalent to a quadrupling of the U. S. number. The following table gives the equivalents from F:4 to F:32. F:11.3 and F:22.6 may be read, for practical purposes, as F:11 and F:22.

U. S. Number	1	2	4	8	16	32	64
F: value	4	5.6	8	11.3	16	22.6	32

***Q.* Would you please recommend a good school of photography?—A. H. W.**

A. It is obviously beyond the province of this department to favor one school above another. And, generally speaking, it would be presumptuous anyway. Really, it makes little difference which school you choose; the chief factor about any school is you, yourself. You will get knowledge from the school in direct ratio to the time, thought, and application you are willing to contribute to the course. No school is any good if you are not willing to do this, if you "throw up the sponge" at the least sign of tough going. Likewise, practically any school is a good school if you *are* willing to do this.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

BECAUSE so many interesting items touching on telescoptics have come to us, we have more and more neglected to publish the photographs of telescopes which their makers have sent us, and we now have about a tubful of them. How useful are such pictures as sources of ideas for design by other amateurs? Figures 1, 2, and 3 show telescopes of a similar type—fork attached to expanded polar axis rotating on rolls, as

Figure 1: **Boven, Minnesota**

in the book "Amateur Telescope Making," fourth edition, page 133, left-hand drawing.

Figure 1 is an 8½", *f*/6 reflector made by Harvey H. Boven, 304 Seventh St., Red Wing, Minn. Tube, galvanized iron. Cell, a Chevrolet hub crown filled with lead (for counterweight). P.A. bearing, an 18½" split wooden pulley on two non-bearing 3" brass rolls "which give me all the friction needed," the maker states. This brings up the fact that too little friction may be a won't-stay-put nuisance unless there is perfect balancing and a clamp. Boven also invites correspondence.

Figure 2 is a 7¼" *f*/8 made by Alfred Bryant, 516 Egleston St., Kalamazoo, Mich. His P.A. bearing is an old gasoline engine flywheel and the P.A. shaft is 1¾" in diameter. To it is attached the gearing of an old phonograph motor with an extension hand rod which is used as a slow motion. Base of fork, heavy washing-machine casting. Sides, boiler plate. Tube, 17 pounds, ⅜" thick, spirally wound paper with five coats of paint, "strong enough to hold an elephant."

Figure 3 was made by L. H. Strum, 232 First St., St. Petersburg, Fla., and has a 15" mirror. The P.A. bearing is braced with four struts.

FOR solar, and often for lunar, observation a telescope often needs some kind of light and heat reducer. In the following paragraphs D. Everett Taylor, 191 Prospect St., Willimantic, Conn., author of the ATMA chapter on the construction of the metal parts and mounting of a refractor, also of various items previously published in the present columns, and always a finished worker, tells how to make a Herschel wedge.

"In 'Amateur Telescope Making', third edition, page 147, and fourth edition, page 179," Taylor says, "the late Prof. Charles S. Hastings closes his chapter on astronomical oculars, with the following paragraph: 'I venture to add the following, under the impression that the Herschel wedge is not nearly as much used as it should be. With it Venus, so unsatisfactory an object in a dark, or darkening sky, is a delightful study. Then the moon, also, except when a rather slender crescent, is much pleasanter to view with this accessory. Ordinarily this object is so brilliant that the pupil of the eye is contracted so that only part, perhaps a small part, of the objective is effective, which may be the cause of a prevalent impression that the moon is too easy an object to afford a test for the excellence of a telescope.'

"Bell, in 'The Telescope,' page 166, briefly describes the solar diagonal devised by Sir John Herschel. He shows a schematic plan of this solar diagonal or Herschel wedge and says, 'In viewing the sun only about 5% of the light (and heat) is reflected at this upper surface to form the image at the eye-

Figure 2: **Bryant, Michigan**

piece.' On an adjacent page, in describing a star diagonal, Bell also says, 'The right angled prism is replaced by a simple elliptical prism of small angle, 10° or less, with its upper face accurately plane and at 45° to the axes of the tubes.'

"The above quotations comprise all the published data known to this writer. Albert G. Ingalls states that he knows of no other literature on the subject, aside from the references here given.

"A Herschel wedge is a most satisfactory accessory and, if constructed after the accompanying drawings, without sacrificing any of the required accuracy, the result will be most gratifying and the performance will leave nothing to be desired. Like the star diagonal, the Herschel wedge is especially suited to and indicated for the refractor. There is, however, no reason why it cannot be used successfully on a reflector—in which case the position of the eyepiece would be changed, and the normal focal and tube lengths of the reflector should permit of being shortened the three or less inches which the light travels through the accessory. There is no appreciable heat from the Herschel wedge when viewing the sun—in fact, with it there is no difference in comfort between sun gazing and star gazing. Attention is called to the glass filter disks (Figure 4). These are used when viewing the sun but are removed from the tube when the wedge is used for viewing the moon, Venus, or the landscape during daylight. The latter is an interesting pastime because of the views one enjoys, especially of trees and their foliage.

"When using the conventional methods, in photographing the sun and sunspots, the work must be hurried because so much heat is generated at or near the focus that a camera shutter which is not of metal is likely to be damaged or destroyed, but by using the Herschel wedge with its filter disks removed there is no necessity for hurrying the work, because the heat is so completely dissipated that this question is no longer a consideration.

"The following notes on construction describe materials and practices used in making the Herschel wedge shown in the drawing, Figure 4.

"Stock: Brass throughout, except the glass wedge or prism. Tubes machined from suitable sizes of brass pipe.

"Prism: Made from plate glass ¼" to 5/16" thick. Angle of finished wedge to be 8° to 10°. Upper surface which reflects the image, if plane to ½ wavelength, is of acceptable quality; ¼ wavelength, however, is better but is sufficiently good. The prism was cut to its cylindrical shape, which looks elliptical, by the method described by Selby, page 126, ATMA.

"Construction: The surfaces between parts *A* and *B* were first machined to a fit,

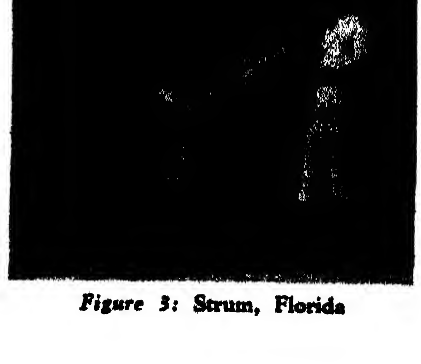


Figure 3: **Strum, Florida**

then the contacting surfaces were carefully tinned and the parts joined by sweating, after which the standard eyepiece O.D. of 1¼" was machined on part *A*.

"The circular intersection on the end of part *C* was machined to fit the circumference of part *B*. It is a safe practice to fill part *C*, before machining the curve, with a turned hard wood mandrel, which will support the wall of the brass pipe when the

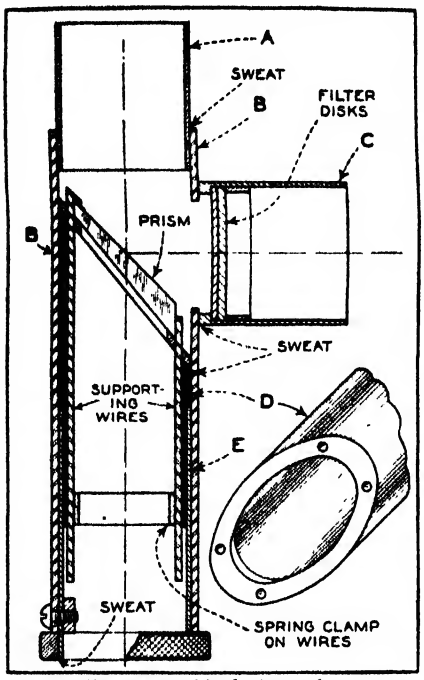


Figure 4: Taylor's wedge

latter is clamped in a two-jaw chuck. The next step is to bore the inside diameter of part *C* to a shoulder which will support the filter disks: The internal diameter of *C* should be the standard 1¼" for a standard size of eyepiece. Locate and bore a 1" hole in part *B*, over which part *C* is to be centered. The contacting surfaces between parts *B* and *C* should be tinned. Part *C* is centered over the hole in part *B* and held firmly in place with several turns of fine iron wire, thus binding the two parts together. By placing three or four pieces of solder the size of a pinhead, on the inside of the tube at the joint, then heating the tubes in a Bunsen flame until the solder flows, a neat soldering job will result, leaving little or no solder in evidence. Working a thin burnisher around the outside of the joint, after soldering, will finish the joint to a high state of perfection.

"Parts *D* and *E* are tubes which assemble inside of part *B*. If preferred, parts *D* and *E* may be combined as one tube. The two-part construction, however, is more complete because it facilitates adjustment and adds to the outside appearance in clean design.

"Part *D* telescopes into part *E*. The friction or fit of joint should be sufficient to hold the parts firmly in adjustment. One end of part *D* is machined to an angle (preferably on a milling machine); this angle, plus the angle of the glass prism, should make 45°. In other words, if the angle of the glass prism or wedge is 8°, the angle of the tube should be cut to 37°; if the wedge is, say, 10° the tube angle should be 35°. On the diagonally cut end of part *D* sweat a piece of 1/16" brass plate to cover the entire angle or elliptical end of the tube. Finish the margins of this newly added

piece flush or parallel with the tube, as shown in the insert drawing.

"A hole is to be bored through the angle face of part *D*, longitudinally with the tube. Therefore, center and chuck part *D* in the lathe. The diameter of this hole should be approximately ⅛" smaller than the diameter of the glass prism. It is assumed that the prism has been made after the method presented on page 126, ATMA, which gives the prism a cylindrical shape with elliptical sections or faces. Therefore, its diameter is the greatest dimension of the prism's width or minor axis.

"Before removing *D* from the chuck, locate the prism on it over the hole, with equal width of brass showing around the prism. Scratch the outline of the prism on the brass base. Outside of this scratched line drill four 1/16" diameter holes, parallel longitudinally with the tube. These holes are to be spotted as shown in the insert drawing, and they are to carry the 1/16" diameter wires which will hold the prism. This method of holding the prism was chosen in preference to several other methods, because it is simple and direct to make, holds the prism securely without pinching it, and simplifies the assembly and disassembly. These four wires should be long enough so that, when in place, they can be seized with pliers through the rear and open end of the complete assembly. Each of the two lower wires which hold the point of the wedge or prism should have a small piece of soft brass or copper soldered on the end, which is to be bent over the prism when in place, thus making a hook. A paper-thin piece of cork should be placed between hook and prism. The other two wires are straight pieces which will easily be understood when the parts are assembled. The clamping ring for holding the four wires in place (also a similar ring for holding the filter disks in place) should be a ¼" to ½" length of thin-wall (.030") brass tubing of suitable diameter. Open this piece of tubing to make the spring, and cut out a piece of the tubing to permit snapping it in.

"Part *E* requires no comment except to call attention to the knurled collar which should be sweated on the end of the tube, also the locking screw with nut in front of the collar, as shown in the drawing.

"Assembly: Telescope part *D* into part *E*. Put the four wires in place and clamp them with the clamping ring. Adjust the upper wires so that they extend through the face of part *D* ⅛" or more. Adjust the lower or hook wires to extend beyond the face of *D* an inch or less. Now place the prism under the upper wires and with pliers pull the hook wires through the clamping ring until the prism is held in place with the hooks. Remember to place the thin piece of cork under the hook just before the hook is made up snug against the prism. The remainder of the assembly is of course obvious, as is also the necessary adjustment. To preserve the outside finish of the brass parts, lacquer them with a thin coat of Bakelite lacquer No. B13128 or BH1805. Allow this to dry for one half hour. Then bake in the kitchen oven for one hour or a little more at 200 degrees F."

IN Figure 5 the Herschel wedge is shown at the left. Near it is a three-lens Ramsden eyepiece made by Taylor and at the right is another of his gadgets, a micrometer focus control. This may be used on any telescope having a standard 1¼" diameter eyepiece fitting and it moves the eyepiece assembly in or out of focus, similar to a rack and pinion. It employs the helical slot principle instead of a thread and Taylor says it is a sweet device in operation. It is also *large enough* to get hold of.

Figure 6 shows Taylor's RFT refractor, recently completed; in fact, he states that it is pretty close to the RRFT specifications in ATMA. It is a 2½" *f*/6 and the knurled band is the rotor of the micrometer focus control shown in Figure 5.

THE following is taken from a letter from H. E. Dall, 166 Stockingstone Road, Luton, Beds., England, a co-author of ATMA: "I've made a strain viewer, using Polaroid, which is so easy and comfortable to use that there is no excuse for working on any untested glass. It consists merely of (1) a lamp in a blackened box having a hole covered with a Polaroid disk, (2) a ground-glass screen on a stand (mine is 10" x 10"), (3) a pair of American Polaroid goggles worn by the viewer. It shows up the strains so brilliantly that there is no need even to test in a darkened room. The glass to be tested is just held between the screen and the observer. The analyzing Polaroid has its axis at right angles to that of the goggle."

WE learn that the Bailey and Sharp Co., Hamburg, N. Y., who handled Chance Bros. optical glass, have sold their manufacturing facilities to the Optical Glass Products Inc., of Hamburg, which will mold lenses, prisms, and other optical parts. The Ednal Company, 160 Fifth Ave., New York, N. Y., are now the American agents for the glass of Chance Bros. and Co., Ltd., Birmingham, England.

CIRCULAR dividing engines are discussed in ATMA, which shows a picture (page 297) of an "ultra" type at the

Figure 5: Upper left, the wedge

Bureau of Standards, capable of dividing a circle within an accuracy of about one second of arc, about a millionth of the complete circle. The late Dr. Ambrose Swasey, the professional telescope builder, made one of comparable refinement and the following, taken from an article in the *Journal of Applied Physics* (New York), written by the astronomer, Prof. J. J. Nassau, of the Case School of Applied Science, Cleveland, may make readers take in their breath.

"Last May Mr. Swasey was asked, 'What in your opinion is the greatest thing you have done?' All at once his eyes sparkled, his face brightened more than ever, and it seemed that a war veteran was getting ready to describe a famous battle. 'The highest type of construction and piece of work I ever did,' he said, 'was the dividing engine. When you can take a spindle 4" in diameter and about 25" long with ⅝" taper to the

foot and make that spindle fit into a bearing easily and when you drop it a thousandth of an inch it goes hard, you are getting down to a refinement about which we knew nothing in those times. Dividing engines had all fallen down on the spindle—could not get a spindle in the bearing that would fit.' The dividing engine was built primarily for graduating circles of astronomical instruments used for fundamental star work as well as for instruments in geodetic surveying. It has an error of closure of one second of arc and required three years in building."

Figure 6: **Taylor's RRFT**

Feats like this rank with making ruling engines—*ne plus ultra.*

ACTIVITIES on 20" reflectors: The New York group—the Optical Division of the Amateur Astronomers Association—have worked a 20" Pyrex disk (20¾"), solid type, to $f/2.4$ curve and are boring it out for a Cass. Their optical workshop is in the basement of the Hayden Planetarium, which provides spacious and ideal quarters. It is even air conditioned—what sybaritic luxury! In Philadelphia the Amateur Astronomers of the Franklin Institute are "exploring possibilities of building a machine to grind the 20" blank," according to their monthly publication, *The Observer.* Their headquarters are in the Fels Planetarium. They have a luxurious machine shop.

A group of advanced engineering students at the College of Engineering, University of Kentucky, Lexington, Ky., is said to be designing and is to build a 20" reflector. Earl G. Welch is one member of this group. At the College of Liberal Arts, University of Louisville, Louisville, Ky., a similar project was under way some time ago, according to Walter L. Moore, but we hear no recent news.

In Boston, the Amateur Telescope Makers of Boston are also planning a 20", and drawings of the proposed mounting were recently published in *The Telescope* (Cambridge, Mass.). The mounting is unique and distinctive: it is half German equatorial, half double yoke and half fork. The tube, like all Gaul, is divided into three parts, the first of which is closed, the middle part absent and the top part latticed. The space occupied by the non-existent middle part is filled up with the ether if there really is an ether, and the top part is held aloft by this ether and/or hypnotism. The Pyrex disk is to be half solid and half ribbed, because there are two schools of thought in this club just as in all others. Similarly, there is to be half a hole in the disk, representing a sensible compromise between the Newtonian and Cassegrainian factions. All this once more shows the marked flair for compromise which we Anglo-Saxons (or what are we?) usually do more bragging about than exercising. The telescope, however, is still in the paper stage and there are hopes that a single type can be settled on—either peaceably by Boston methods, or by a gang fight à la New York.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

THE MCKAY PHOTOGRAPHIC TEST CHART is a four-color chart which enables the photographer to check his equipment—lenses, filters, films, developers—and technique. The four-color chart (15 by 20 inches, mounted on durable board) is photographed in the usual manner; the resulting negatives and prints reveal various sources of trouble that may have been preventing the photographer from obtaining the best possible results. The chart folds to 15 by 10 inches. *At your photographic dealer or direct from Chess-United Company, Mohawk Building, Fifth Avenue at 21st Street, New York City.—$2.50.*

HOW TO MAKE TIME AND MOTION STUDIES, by Howard Campbell, is a pamphlet of interest to plant executives and managers. It gives information regarding the proper method of making time and motion studies with an eye to increased plant efficiency. *Write for Bulletin 438A to Scientific American, 24 West 40th Street, New York City.—3 cents.*

FOREIGN LANDS AT STAY AT HOME PRICES is a revised edition of a booklet that deals particularly with "freighter cruises." It tells of the advantages of this inexpensive method of travel, quotes prices, and gives brief sketches of the interesting trips that can be made. *Harian Publications, 270 Lafayette Street, New York City.—25 cents.*

RIGGERS' HANDBOOK is an up-to-date manual showing the latest equipment for handling materials by means of cranes of various types. It illustrates the latest accessories and technique and gives complete specifications and dimensions. *Write for Bulletin 438B to Scientific American, 24 West 40th Street, New York City.—3 cents.*

GEORGE WESTINGHOUSE is the title of a 78-page illustrated book on the life and work of George Westinghouse and those with whom he worked. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—Gratis as long as a limited supply lasts.*

PROGRESS IN IMPROVEMENT OF CAST IRON AND USE OF ALLOYS IN IRON, by Paul D. Merica, is a reprint of a lecture delivered before the American Institute of Mining and Metallurgical Engineers. *Write for Bulletin 438C to Scientific American, 24 West 40 Street, New York City.—3 cents.*

THE MICROSCOPE, a magazine for microscopists, described in these columns in our January issue, is published in England. United States and Canadian residents can place their orders for subscriptions through *Harry Ross, The Merchandise Mart, 84 West Broadway, New York City.—$3.00 per year.*

PHOTORELAY UNIT is an eight-page pamphlet describing new types of relays for use with photo cells in such applications as fire alarms, smoke alarms, burglar alarms, illumination control, counting, and so on. Descriptions of various applications are given as are also prices of the units described. *Write for Bulletin 438D to Scientific American, 24 West 40th Street, New York City.—3 cents.*

HOW TO ENLARGE, by W. Peterhans, is a pocket-size manual on the subject which gives compact yet complete directions on the proper making of enlargements. *American Photographic Publishing Company, 428 Newbury Street, Boston, Massachusetts.—50 cents.*

THE OLD PATHS OF CONSERVING THE AMERICAN TRADITION, by Frank Halliday Ferris, is a transcript of a sermon recently delivered, which dealt particularly with present-day conditions in the United States and with some of the solutions which have been offered. Words are not minced in the treatment of the all-too-wide-spread philosophy of a new Utopia in which hard work is to be avoided. *Write for Bulletin 438E to Scientific American, 24 West 40th Street, New York City.—3 cents.*

USED CAR VALUE GUIDE is a small folded sheet that gives definite information on the points to be watched when buying a used car. Check-lists furnish an easy means of analysis. *Automobile Research Bureau, 520 North Michigan Avenue, Chicago, Illinois.—25 cents.*

WHAT IS A JOB is an 18-page booklet that tells the human side of the various factors that go to make up a job. It is designed particularly to stress the necessity of a better understanding of these factors and their relationship to employment. *General Motors Corporation, Detroit, Michigan.—Gratis.*

DIRECTORY OF ASSOCIATION MEMBERS, 1938 edition, lists consulting chemists throughout the country and tells specifically of the particular work which these leading research men are prepared to undertake. If you have a chemical research problem to solve you will undoubtedly find the best man for the job in this listing. *Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st Street, New York City.—Gratis.*

ANNUAL REPORT OF THE GOVERNOR OF THE PANAMA CANAL, 1937, is a formal report, with the usual statistics, but it is also less "statisticky" than most reports and more readable. It gives to the American citizen a good idea, in detail, of the way his investment at Panama is being handled. *Superintendent of Documents, Washington, D. C.—15 cents, cash.*

GEOPHYSICAL ABSTRACTS 88 (Geological Survey Bulletin 895-A) is a pamphlet containing abstracts of numerous papers pertaining to geophysical prospecting, covering January to March, 1937. *Superintendent of Documents, Washington, D. C.—10 cents, cash.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

PRICE CUTTING

ON several occasions we have referred to the so-called Fair Trade Acts which have been enacted in many of the states. These Acts permit a producer or distributor to fix by contract the re-sale price at which merchandise bearing his trade mark, name or brand may be sold. Most of these Acts provide that knowingly selling merchandise below the price fixed in the contract constitutes unfair competition. The constitutionality of these Acts and the right of a producer or distributor to maintain a suit for unfair competition where a retailer sells below the specified price has been sustained by the United States Supreme Court.

The New York State Supreme Court recently had occasion to pass upon a rather novel application of the Act. A retailer brought suit against a competitor, charging that the competitor was guilty of unfair competition because he was knowingly selling merchandise bearing the trade mark of the producer below the price specified by the producer. The Court dismissed the suit on the grounds that the Fair Trade Act was intended to protect the good will of the producer or distributor rather than the retailer. The Court further pointed out that the Act provided for vertical price maintenance as distinguished from horizontal price maintenance. The basis upon which the Court dismissed the suit is summarized in the following quotation from the Court's opinion:

"In other words, while the enforcement of the contract may be obtained at the instance of the producer or wholesaler against the retailer, the same right to enforce the contract does not vest in another retailer."

OUTSIDE THE PALE

IN a case of more than usual importance, the United States Supreme Court has decided that a patentee cannot prevent the sale by a competitor of an unpatented product which is to be used by the purchaser in an infringing process or product. Prior to this decision there had been some confusion as to whether the seller of an unpatented article of commerce, which was subsequently used in a patented process or product, was guilty of contributory infringement and as such liable for profits and damages to the patentee.

In the case in question a prominent manufacturer of asphalt and bituminous products was the owner of a patent for the process of curing concrete, as used in road building, by means of a bituminous emulsion. Purchasers of the bituminous emulsion from the patentee were permitted to use the patented process. A competitor of the patentee sold bituminous emulsion to road builders knowing that they intended to use it in the patented process without license from the patentee, and the patentee brought suit against the competitor charging that the sale of the bituminous emulsion contributed to the infringement of the patent.

The history of this case from the Trial Court to the Supreme Court reveals considerable judicial conflict. Thus, the District Court before which the case was tried held that the patent was invalid and dismissed the suit. The Circuit Court of Appeals reversed the District Court and held that the patent was valid and infringed by the sale of the bituminous emulsion. The United States Supreme Court reversed the Circuit Court of Appeals and held that anyone had the right to sell the bituminous emulsion as it was an unpatented article of commerce. The Supreme Court pointed out that if the seller of the bituminous emulsion was held to be an infringer, the patentee would be granted a limited monopoly on the sale of an unpatented product. In this connection the Court stated:

". . . every use of a patent as a means of obtaining a limited monopoly of unpatented material is prohibited. It applies whether the patent be for a machine, a product, or a process. It applies whatever the nature of the device by which the owner of the patent seeks to effect such unauthorized extension of the monopoly."

This unequivocal statement by the Supreme Court would appear seriously to curtail, if not destroy, the doctrine of contributory infringement as previously expounded by many experts.

CO-OWNERS

THERE is a great deal of misunderstanding as to the rights of co-owners of a patent. It is frequently thought that co-owners must share all profits received from exploiting the patent. Also, it is often stated that where a patent is jointly owned by two or more people a license to practise the invention of the patent must be granted by all of the co-owners.

However, in the absence of a partnership, joint venture, or some definite understanding to the contrary, each of the co-owners of a patent has the right independently to promote and exploit the invention without accounting to the other co-owners.

A Federal District Court considered this question in a recent case, and made the following comment:

"For example, one co-owner of a patent right, whatever his undivided interest may be, may exercise that right as he pleases, regardless of the consent of any co-owner. Thus, no recovery of profits or damages can be had against such a co-owner if, without the consent of the others, he makes, uses, or sells the patented invention. That is to say, he may, at will, make, use, or sell the patented invention or license others to do so, and neither he nor his licensees may be enjoined from so doing."

RUBBER TIRE

THE provision of a rubber tire for a lawn mower does not amount to invention, according to a recent decision of the Court of Customs and Patent Appeals.

The tribunals of the Patent Office rejected a patent application for a demountable rubber tire for a lawn mower and the applicant for the patent appealed to the Court of Customs and Patent Appeals. The Court found that similar rubber tires had been used on perambulators and on children's wagons and concluded that the use of the tire on a lawn mower did not involve invention. The court stated:

"As we see it, appellant has done nothing more than use a well-known old art vehicle tire for a lawn mower without any modification which required invention."

FOLDING BOX

INFRINGEMENT of a patent for a folding paper box formed of a single strip of paper is not avoided by forming a box from two strips of paper glued together.

In a recent suit for patent infringement the patent disclosed a hexagonal folding hat box formed of a single strip of paper. The infringer made his box from two separate strips of paper but in other respects it was substantially the same as the patented box. The court pointed out that making an element in two pieces when it is described in the patent as being formed of a single piece does not avoid infringement where the elements function in substantially the same manner. In reaching its conclusion the court pointed out:

"Thus appellee's box, although formed of two parts, fastened together by glue, is an integral structure; it operates and functions identically with the box made under the patent and does not avoid infringement."

REVISION

A COPYRIGHT on a book or play does not protect revisions made after the copyright was obtained. This question was recently considered by a Federal District Court in a suit charging that a photoplay was an infringement of a copyright on a play. The bill of complaint alleged that the plaintiff had written and copyrighted an original drama. After the copyright was obtained the complaint alleged that the play was revised, and it was charged that the photoplay copied the revised version of the copyrighted play.

So far as the complaint revealed, no copyright was obtained on the revisions or on the revised version of the play. The Court held that the copyright on the original play did not protect the revisions, and that in so far as the suit charged the defendant with copying the revisions it should be dismissed. The Court pointed out that a new copyright could have been obtained on the revised version of the play and in that manner the plaintiff could have protected himself.

Books SELECTED BY THE EDITORS

SUNSPOTS AND THEIR EFFECTS

By Harlan True Stetson, Research Associate, Massachusetts Institute of Technology

IN this volume the author, now the most outstanding scientist in the combined fields dealt with, has compacted a vast amount of information on the sun: sunspots and human behavior (ups and downs of our feelings); sunspots and growing things (tree-ring cycles, plant growth, vintages, animal fluctuation); sunspots and radio; sunspot periodicity and business (the much-talked-of parallelisms); measuring sunlight; weather and sunspots (long-range prediction); solar utilities; light and power; earth's magnetism (including theory of its effect on carrier pigeons); sunspot causes and prediction. His treatment is popular and most readable. Big things, largely practical, are expected to follow from the studies now being made of these subjects. (201 pages, 5¼ by 8 inches, 15 illustrations.)—$2.15 postpaid.—*A. G. I.*

DISTILLATION

By J. Reilly

THIS work has been carefully and thoroughly carried out by Professor Reilly, who is a technical member of the Irish Free State Industrial Advisory Board, and is an authority on the azeotropic process. In this book some of the newer developments have been considered both from the theoretical and industrial aspects, as, for example, evaporative distillation and the azeotropic dehydration of alcohol. (120 pages, 4 by 6½ inches, illustrated with drawings.)—$1.35 postpaid.

THE COMMAND TO LOOK

By William Mortensen

"A FORMULA for picture success" is the sub-title of this little book made up with plastic spiral binding. The author claims to have discovered a "definite photographic formula" by means of which he is able to produce effective photographs. The purpose of the present book is to tell of the discovery of this formula, analyze it in detail, and show its concrete application in a series of prints that have won the approbation of publishers and salons. The book does not touch upon technical problems; it is solely concerned with the making of effective pictures. If you are serious about your photography and can learn by reading of the experience of others, this book should provide much inspiration. (190 pages, 4½ by 5¾ inches, drawings, 56 photographs.)—$2.15 postpaid.—*A. P. P.*

SEGMENTAL FUNCTIONS TEXT AND TABLES

By C. K. Smoley

PRIMARILY a compilation of logarithms of segmental functions, this is a volume for advanced engineers and mathematicians. It offers simple methods of solving a circular segment, and of computing its area, when the segment is given with any two of its five parts, viz., the arc, the chord, the radius, the central angle and the height, with numerous examples illustrating the application of these methods. (Limp leather, 491 pages.)—$5.15 postpaid.—*F. D. M.*

THE NATURE OF VARIABLE STARS

By Paul W. Merrill, Mt. Wilson Observatory

A COMPACT outline of our present knowledge of variable stars: how variables are discovered and catalogued, how their light changes, what the spectroscopes show, their motions and their significance. The treatment is semi-technical—certainly not typically popular but not abstruse; in other words, it is well adapted to its logical readers—serious amateurs. (134 pages, 5¼ by 8 inches, 12 illustrations.)—$2.15 postpaid.—*A. G. I.*

THE MATTHEWS-NORTHRUP NEW INTERNATIONAL ATLAS AND ILLUSTRATED GAZETEER

ATLASES come and atlases go, and it is seldom that the layman who desires an atlas for the home is able to determine which one would best suit his needs. This volume is a most convenient home reference atlas, and particularly for those who, like this reviewer, pore over a map for hours at a time, making their world tours vicariously in an armchair. Complete detailed maps of all sections of the world are given, and in the Gazeteer there are compact descriptions of all those queer places you have always wanted to visit, from hot and dusty Aden to the Zanzibar Protectorate which, we learn, produces 82 percent of the world's supply of cloves. Other features are: important dates in world development, facts and figures concerning areas, rivers, mountains, waterfalls, dams, tunnels, and—but, briefly, it is practically an encyclopedia of facts concerning the physical world. (264 pages, 11 by 14 inches.)—$3.15 postpaid.—*F. D. M.*

ECONOMIC GEOLOGY

By H. Ries, Prof. Geology, Cornell

FOR a generation Ries' "Economic Geology" has remained a standard text on its subject, since its author has consistently kept it up with the changing times. This is the seventh edition and large sections have been completely rewritten. As a text, and particularly as a concise, dependable reference, this work in its successive editions has been kept for years on the reviewer's desk, as it contains the answers to many a practical question asked by readers of this magazine. Its emphasis is mainly on industry, not on abstract geology. Part I, on the Non-metallics, covers coal, petroleum, natural gas, bitumens, oil shales, building stones, clay, limes, calcareous cements, salt, bromine, calcium chloride, borates, iodine, potash, gypsum, phosphates, abrasives, asbestos, glass sand, graphite, monazite, and precious stones. Part II, on Ore Deposits, covers iron, copper, lead, zinc, gold, silver, aluminum, manganese, mercury, and the minor metals. Most of these items have their own separate chapters and the ground covered in each is shown by a typical sample, the chapter on gypsum: properties and occurrence, impurities, origin, distribution in the United States and Canada (area-by-area, with maps), typical analyses, uses, amount and value of production, references to literature. A ruggedly bound, practical book. (720 pages, 6 by 9 inches, 267 illustrations.)—$5.25 postpaid.—*A. G. I.*

ATLANTIC GAME FISHING

By S. Kip Farrington, Jr.

ADVENTURE on the briny deep is the key-note of this beautifully produced and handsomely illustrated volume. Fishermen of all kinds will go for it in a big way; non-fishermen who thrill to factual adventure stories will get as much from it as will a fisherman who has been on the right end of a fishing line at the right time. The author covers the subject of salt water fishing from Nova Scotia to Bimini—from dories, from high-powered motor boats, from the beach. Part instruction manual, but all intensely interesting reading, the book tells what to fish for, where and how. (298 pages, 8½ by 11½ inches, 125 action photographs, and seven full color paintings by Lynn Bogue Hunt.)—$7.75 postpaid.—*A. P. P.*

CATALYSIS

By Georg-Maria Schwab. Translated from the first German Edition with addenda by H. S. Taylor and R. Spence

CATALYSIS, the remarkable effect of accessory substances on chemical reactions, remains somewhat of a mystery despite the vast amount of research devoted to it and the enormous importance of its industrial applications. In this volume an outstanding German treatise on catalysis has been amplified and brought up to date by eminent authorities, American and English. The result is a book of greatest value to the student and to others interested. The presentation is clear and covers the field in an understandable manner, but without sacrificing subject matter. (369 pages, 6 by 9 inches, unillustrated.)—$4.45 postpaid.—*D. H. K.*

METAL AIRPLANE STRUCTURES

By Major Flavius Loudy

WHEN airplanes were built of wood, their structure was simple and well-nigh standardized. Now that aircraft are built almost solely of aluminum alloys and stainless steels, the variety of structural forms and the complexity of structures are much greater. There are riveted and welded

joints to think of. Fuselages may be of tubular steel, monocoque, or semi-monocoque, with every imaginable type of bulkhead and stringer. Wings are metal covered and the metal covering is made to give a large proportion of the strength in what is known as the stressed skin design. Metallurgical knowledge has to be brought into play, methods of stress calculation are exceedingly complicated, and sometimes the best calculations have to be supplemented by tests to proof load and to destruction. The very difficulties and complexities of the subject make Major Loudy's book all the more attractive for the technician or the practical constructor. Consideration of structural elements is supplemented by concise and practical suggestions for calculations. The many illustrations give a very fine survey of modern practice. Even the private flier or the layman interested in knowing how the airplane appears under its skin will read the book with pleasure and benefit. (445 pages, 293 figures.)—$5.20 postpaid.—*A. K.*

THE SECRETS OF TRICK PHOTOGRAPHY

By O. R. Croy

PHOTOGRAPHY without a camera, moonlight—real and faked, homemade snow flakes, silhouettes, photography of glass, photographic ornaments, optical caricatures, photomontage, pencil drawing with the camera, printing on silk—these and dozens of other subjects are thoroughly covered in clear, compact style. In general, the text for each subject comprises a single page with, facing it, a full page photograph illustrating the effect described. The amateur photographer who is looking for new ways of photographing old subjects or for obtaining odd and unusual results will find straightforward and practical instructions in the pages of this book. (174 pages, 6 by 8½ inches, thoroughly illustrated with photographs and diagrams.)—$2.65 postpaid.—*A. P. P.*

AXIAL BIFURCATION IN SERPENTS

By Bert Cunningham, Duke University, with Foreword by Raymond L. Ditmars

AN author with a passion for double-headed, two-tailed and Siamese twin snakes has fine-tooth-combed the past scientific literature of several languages and brought together in one book all available previously published scientific descriptions of these freaks. (91 pages, 6 by 9 inches, 134 illustrations.)—$2.65 postpaid.—*A. G. I.*

MIGHTY ENGINEERING FEATS

By Harriet Salt

AS the title implies, this is a running account of some of the greatest structures made by man. The background, general history, details of construction, and dates, are given for such projects as the first transcontinental railroad, the Panama Canal, New York City's water supply system, the Wilson Dam, the Holland Tunnel, the Columbia River Highway, the George Washington Bridge, Boulder Dam, and the two monumental new bridges at San Francisco. The style is free and readable, and those who are interested in such achievements will find the book fascinating. (308 pages, 6½ by 9⅜ inches, illustrated.)—$2.70 postpaid.—*F. D. M.*

ARMATURE WINDING

By David P. Moreton, Carl H. Dunlap, L. R. Drinkall

"PRACTICAL" is a word that describes this book from beginning to end. It deals with the construction, winding, and repairing of A.C. and D.C. motors and generators, all of the steps being clearly shown in photographs and drawings. (280 pages, 6 by 8½ inches, well illustrated.)—$2.15 postpaid.—*A. P. P.*

EARLY MAN

Edited by George Grant MacCurdy, Director American School of Prehistoric Research

THIS book contains the 36 scientific papers delivered by the world's outstanding anthropologists at the notable International Symposium on Early Man held last year at Philadelphia. These cover research on ancient man in Java, Palestine, Norway, China, India, The Pacific, South Africa, and Japan, the main emphasis, however, being on American paleoanthropology. To readers not already familiar with the literature of ancient man, also without some knowledge of geology, this will seem to be an advanced work. To others it will be a notable collection. (362 pages, 6 by 9 inches, 82 illustrations.)—$5.20 postpaid.—*A. G. I.*

HANDBOOK OF CHEMISTRY AND PHYSICS—22nd Edition

Charles D. Hodgman, Editor-in-Chief

THIS handbook of chemical, physical, and mathematical data has through its many editions become a standard reference on the subjects covered. New information is added and tables are revised with each reappearance to keep it fully useful and up to date. Its 2090 pages represent a veritable library of data readily available in laboratory or office. Not only is it useful for practicing scientists, but students in science will also find it of great value.—$6.25 postpaid. —*D. H. K.*

OUTLINE OF HISTORICAL GEOLOGY

By Charles Schuchert, Prof. Emer. of Paleontology, Yale; and Carl O. Dunbar, Prof. Pal. and Stratigraphy, Yale

THE third edition, now entirely rewritten, of a brief but well illustrated outline of earth history, by the authors of the longer historical geology reviewed in these columns last July; it is based, in fact, on that book. It is described as a telescopic rather than a microscopic view of the great panorama of the geologic past, giving depth and perspective rather than detail, hence the more common systematic period-by-period treatment is avoided. It presupposes an elementary knowledge of physical geology. (241 pages, 6 by 9 inches, 151 illustrations.)—$2.65 postpaid.—*A. G. I.*

SCIENTIFIC AMERICAN

ADVERTISERS

April · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City

Western Advertising Representatives

EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.

BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President   JOHN P. DAVIS, Treasurer   I. SHELDON TILNEY, Secretary

Vol. 158, No. 4, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorised. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS · MAY · 1938

THE Bell XFM-1 fighting plane, illustrated on our front cover through the co-operation of the U. S. Army Air Corps, has been designed to fill the need created by the introduction in military air forces of the large high-speed four-engined bomber. A multi-place, all-metal, twin-engined pusher-type monoplane, the XFM-1 has a top speed with full load of better than 300 miles per hour. Equipped with the most powerful armament ever before carried on a fighter, it can handle in addition a load of light bombs.

SCIENTIFIC AMERICAN, May, 1938. Vol. No. 158, No. 5, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1888)

COAL IN THE MAKING—"During the late violent storms in the Channel the sea washed through a high and hard sand bank near the Isle of St. Malo, France, nearly four meters thick, laying bare a portion of an ancient forest which was already passing into the condition of coal."

BRIDGE—"Owing to the enormous expense of acquiring real estate for the construction of the approaches and termini of bridges in populous districts, a most interesting engineering problem is presented in the designing of bridges in which this difficulty is to be avoided. The bridge illustrated in the accompanying engraving is of this type, the shores being little above the water level, the stream

being a navigable one, and the necessary condition being that the span should be sufficient to allow several ships to pass under simultaneously, and of sufficient height to permit vessels of ordinary size to pass under without the necessity of opening the draw."

GUM—"The high price of gum acacia has led Trojanowsky to seek for a substitute. This he believes may be found in the mucilage of flax seed. By boiling the seed with water and precipitating the strained decoction with twice its volume of alcohol, he obtained a substance which, after drying, consisted of opaque, yellowish-brown irregular fragments, somewhat brittle, but not easily reduced to powder, dissolving in water to a turbid mucilaginous solution."

LACKING—"The King of the Belgians recently sent to the Sultan of Morocco a present of a locomotive and a Pullman car. The difficulty is that there is no railway in Morocco!"

TELEGRAPHY—"It is a matter of considerable pride to the operators of the Western Union Telegraph Company in San Francisco . . . that the feat of transmitting clock signals through 7,200 miles of line and communicating directly through that same line has never been equaled."

CANNON—"The ordnance department of the army has received from Mr. Hiram Maxim, of England, the description of a new dynamite gun which he has projected. . . . He mixes with compressed air a quantity of volatile hydrocarbon, such as the vapor of gasoline. This compressed mixture is introduced behind the projectile and the pressure is applied to start it forward in the chamber of the gun. After it has moved a certain distance the projectile itself uncovers a detonating fuse and an explosion then occurs, the air furnishing the oxygen for the explosion and the pressure being increased about eight times. . . . By this means he hopes to render the use of dynamite in projectiles practicable in big guns."

MICA—"The peculiar physical characteristics of mica, its resistance to heat, transparency, capacity of flexure, and high electric resistance, adapt it . . . to applications for which there does not appear to be any perfect substitute. Its use in windows, in the peep holes on the furnaces used in metallurgical processes, as well as the ordinary use in stoves for domestic purposes, are examples of its adaptability to specific purposes which it does not seem to share with any other material."

PLANT GROWTH—"Prof. Sachs, the celebrated German botanist, has discovered that the ultra-violet and invisible rays of the solar spectrum especially promote the development of flowers, the growth of which is exceedingly feeble when the rays are suppressed, although that of the other parts of the plant is very luxuriant."

ANCIENT—"The oldest arm chair in the world is the throne of Queen Hatafu, who flourished in Egypt 1,600 years B.C. It is of ebony, beautifully carved. It is now one of the treasures of the British Museum."

OYSTER FARMING—"The method of farming most successful in America consists in depositing oyster shells upon the bottom, just before the spawning season, to which the young attach themselves, and then placing among the shells a few mature oysters to furnish eggs and young. As soon as the young oysters caught in this manner are large enough to handle, they are distributed over the bottom."

BISON—"Mr. Clinton A. Snowden of the Chicago *Times* is the originator of a scheme to save bison that still remain on the plains. It has been ascertained that of the millions which once roamed on the prairies of the West only seventy-five or a hundred remain. . . . It is to be hoped this laudable expedition will succeed. It would seem as if Congress might do something to promote and encourage the preservation of this wonderful breed of animals."

PHONOGRAPHS—"The improvements in the phonograph have now been carried to such a degree of perfection that the instrument is practically ready for general introduction. Undoubtedly mean will be hit upon from time to time to enhance the value and efficiency of the phonograph, but it stands today, in our opinion, far more practical and complete than was the typewriter when first brought out and placed on the market. Back of all the tall talk and exaggeration on the subject . . . is a machine of admirable performance, whose utility is so wide and various that it is hard to determine just which work will give it the largest field of employment. . . . And then, too, is the wonder . . . that not only can the human voice be registered, but it can be duplicated in countless electrotypes."

AND NOW FOR THE FUTURE

Ultra-violet light put to work as a practical germ killer, by F. D. McHugh.

How plant "wizards" develop important new fruits, vegetables, and flowers, by Keith C. Barrons.

Transatlantic telephony—a story in photographs, by A. P. Peck.

Personalities of the elements, and how they affect metal structures, by Sidney J. French, Ph. D.

How do you know you can't eat onions?, by T. Swann Harding.

Personalities in Industry

TRAVELING eastward on The Twentieth Century Limited, you are surprised when it comes to a grinding halt at South Bend; ordinarily this crack train does not stop at the Indiana city. Suddenly there appears in your car a broad-shouldered, brown-haired man, surrounded by several companions. The group at once plunges into earnest conversation and you are struck by the incisive tones of the central figure, the sweep of his hand, his bright eyes, his almost boyish enthusiasm. If at Elkhart several more persons climb aboard and join the conference, you may be sure that the broad-shouldered man is Vincent Bendix.

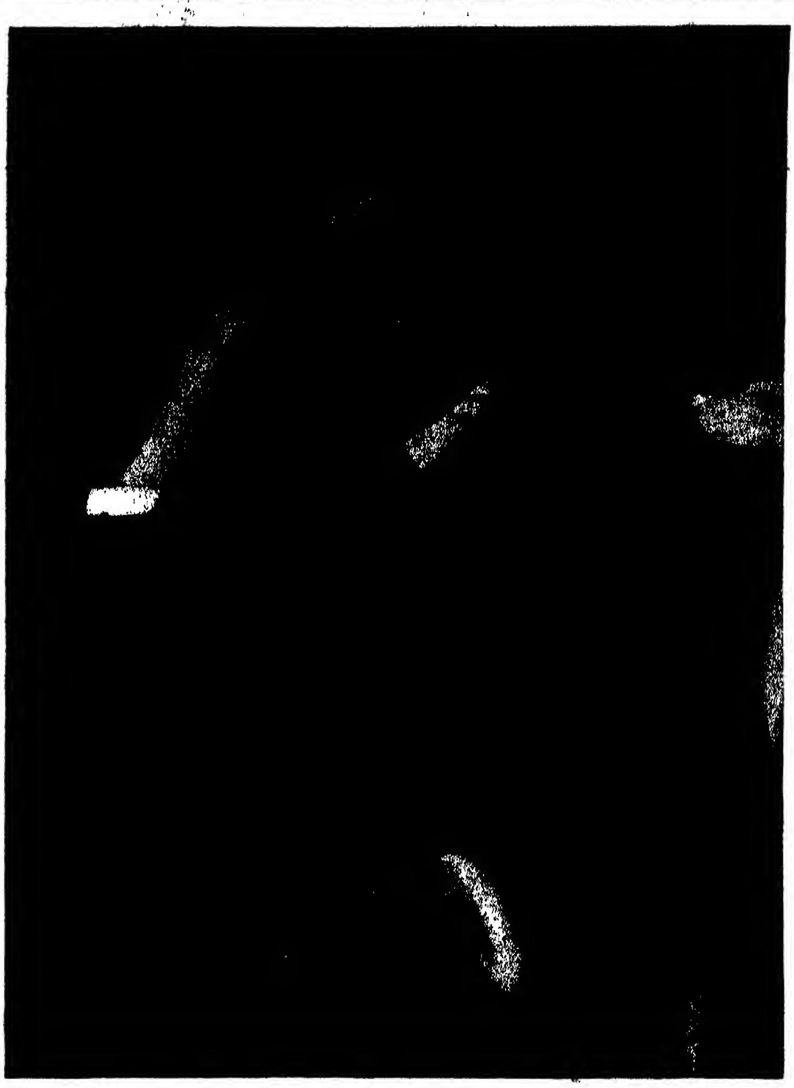
Vincent Bendix leads a busy, active life, consistent with his position as one of America's leading manufacturing and inventive figures; wasted moments are few. Decisions are frequently made between his South Bend factory offices and his New York headquarters, from where he can look across the Hudson and see his newest factory rising at Bendix, New Jersey, or while he travels across the Atlantic, to the South, or to California.

Vincent Bendix as a boy left his Illinois home filled with the ambition of youth, and now actively heads 32 corporations. He who once operated an elevator in New York today sees airplanes equipped with his products rise into the sun all over the globe. And the young man who started his actual business life in a motorcycle shop is now internationally known as the inventor of the Bendix Drive of which more than 60 million have been used on the automobiles of the world.

On land or sea or in the air, some Bendix product will be found—carbureters in automobiles and airplanes; radio direction finders on ships at sea; starters, generators, magnetos, landing gear, brakes, and many other devices on great transport planes; even outboard motors for recreational purposes.

While still in his early teens, Vincent Bendix worked on plans for a chainless bicycle, and when nothing came of a long correspondence with a manufacturer, he left his clergyman father's home and came to New York. At 17, Bendix was a stenographer in a law office, meanwhile picking up the fundamentals of mechanics from a building superintendent and a knowledge of electricity from an Edison official.

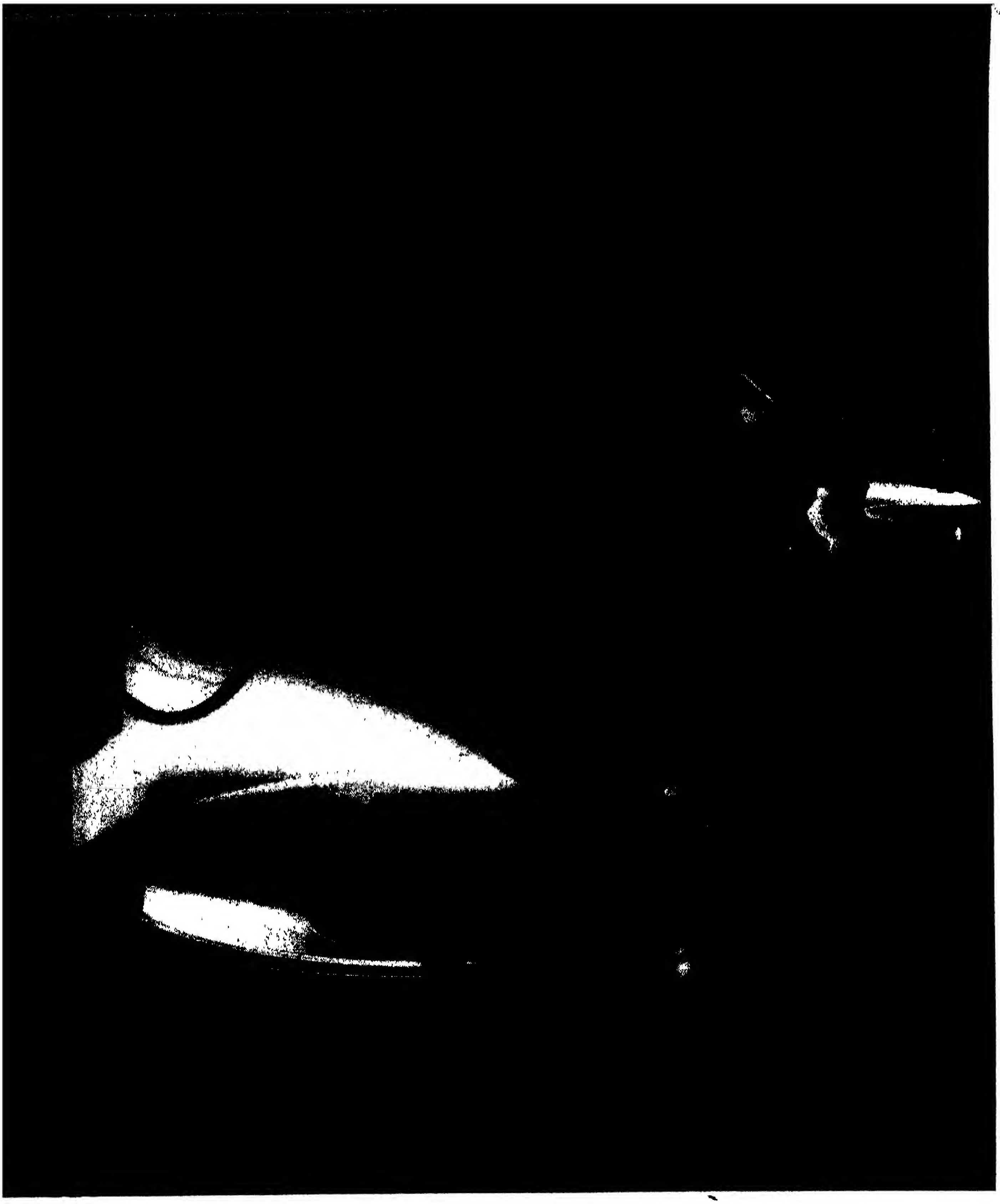
The first definite step toward his chosen field was made by the youthful Bendix when he bought a second-hand motorcycle. True to form, he soon worked out improvements on the machine he rode. He engineered the design and supervised the building of the experimental machine in a bicycle shop in New York City. He filed application for patents on this spring frame motorcycle and then took it to Hammondsport, New York, and showed it to Glenn H. Curtiss. Curtiss wanted his new friend to become a partner; "V.B." likes to reflect that, at 19, and for only 1000 dollars, he might have taken a half interest in what was to become a great business. But even broader fields were in store for the boy from Illinois.



VINCENT BENDIX

Today the Bendix realm includes, among others, the Bendix Aviation Corporation, Bendix Products, Eclipse, Bendix Radio, Scintilla Magnetos, Hydraulic Brakes, Jaeger Watch, Friez weather equipment, Pioneer Instruments, and, more recently, Bendix Home Appliances, manufacturers of an automatic home laundry.

Business is the dominating passion of his life, but he has many side interests. His 25,000 dollar prize, annually awarded for the National Air Races transcontinental classic, is known throughout the world of aviation, as is the Bendix Glider Trophy in the world of motorless flight. His was the moving spirit that brought the Golden Lama Temple to the World's Fair in Chicago, and he also aided the trust that gave the museum at Stockholm, Sweden, its magnificent collection of Asiatic ecclesiastical art. He has been decorated with the Legion of Honor of France; he is a Knight Commander of the Order of the North Star, an honor from King Gustave of Sweden.



HIGH FINISH ON A DISK AT HIGH SPEED

At some stage in the manufacture of almost all metal products, they must go under treatment with an abrasive—sometimes once, often several times. It may be that a disk is polished with a grinding wheel, as in this photograph which was supplied by The Norton Company, or it may be that abrasives cut steel tubing to make modern furniture, grind telescope mirrors, or cut and polish gem stones. Abrasives (see page 266) made and operated under rigid control now play a major part in the steady march toward greater precision in mass production.

Wheeler Dam, near Muscle Shoals in Alabama, which was recently dedicated by the TVA. In this photograph, this important dam has just been drawn down for malaria control, as indicated by the exposed shore

Flood Forecasting

Daily Gaging of Tennessee Valley Stream Levels and Rainfall . . . Dams Store or Release Water Accordingly . . . For Flood Control, Navigation

By HERBERT F. GOUGH

KEEPING tab on an annual cycle of 145,000,000,000 tons of water—recording its movements, anticipating its whims, and manipulating the proper mechanical checks and restraints—furnishes a sizable demonstration in modern water control methods. Such a demonstration, definitely needed in America today, is now in progress in the Tennessee Valley. In fact, for the first time in history, man is in the driver's seat and holds the reins of control on a river of major proportions.

Four years ago the nation massed its technological forces under the Tennessee Valley Authority and began its program aiming at the orderly development of the water resources of the Tennessee basin.

The Tennessee basin problem may be stated numerically—52 inches of rain a year, distributed over 41,000 square miles of territory that varies from mile-high mountains to low flood plains only a few hundred feet above sea level. This is twice as much rainfall as occurs in the Missouri Valley, and approximately one and one-half times that of the Ohio Valley.

The storms that contribute most of this rainfall come from the Gulf and occur during the months of December to April inclusive. Thunder-storms, coming from the west, occur during the West Indian hurricane season from July through November. An equally serious menace during these summer months comes in the form of tropical storms from the Atlantic coast. Without warning, moisture-laden winds swing in from the coast and have to travel but a short distance before striking the high southern Appalachians. There they release torrential downpours into the drainage areas of the Watauga, French Broad, Pigeon, Little Tennessee, Hiwassee, and Ocoee Rivers, all of which flow westward into the Tennessee.

THE fluctuations in the Tennessee River correspond to these wet and dry seasons. During summer, the flow at Knoxville often drops to a flow of 3000 cubic feet per second. Several months later, following the winter and spring rains, the river has increased its depth by 23 feet and the volume of flow is over 100,000 cubic feet per second. On the lower river beyond Muscle Shoals, the seasonal discrepancy is even more alarming. At Pickwick Landing, when there is no regulation, the flow drops to as little as 7000 second-feet. Under flood conditions, however, the river will increase 44 feet in depth and, bursting over its banks, attain a flow of 318,000 second-feet. The highest stage on record occurred in March, 1867, when the discharge was 428,000 second-feet at Chattanooga.

This annual flood menace is aggravated by the peculiar break in the natural direction of flow of the Tennessee itself. In early geologic times the Tennessee River flowed from its present upper basin in eastern Tennessee through a channel which extended southwesterly from a point somewhat downstream from Chattanooga to the vast embayment which has since receded to form the Gulf of Mexico. A subsequent uplift of the

earth's crust blocked this old outlet, thus diverting the upper river into its present lower basin, which extends westward and then north.

The danger in this situation lies in the fact that it prevents a co-ordinated flow of flood waters down the river. The topography of the lower basin is low and rolling, and the run-off is much slower than in the eastern end of the Valley. The rains in the lower basin cause flood crests that recede slowly, retarded not only by low gradient but by backwater from the Ohio at the mouth of the Tennessee River. It is not uncommon for a swiftly moving crest from the upper basin to reach and further augment one that has not yet drained out of the lower river.

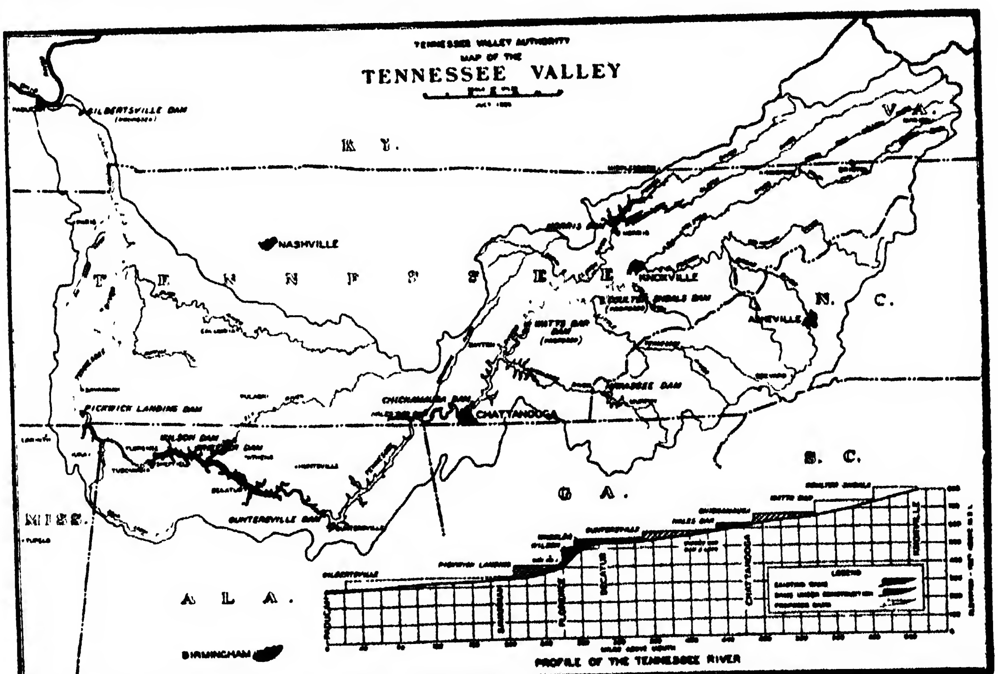
It is estimated by engineers that the maximum run-off that may be expected in the upper Tennessee Basin is about 34 cubic feet per second per square mile of territory. The upper basin is 21,400 square miles in area. This means that, barring regulation, it would not be unreasonable to expect a flow of approximately 730,000 cubic feet per second in the Tennessee at Chattanooga.

Such is the volume of water that must be controlled as a public enemy or put to work in the service of mankind. The Tennessee Valley Authority is using every reasonable method toward this end. The approach is twofold. On the one hand, improved farm management practices aiming at increased ground-water storage by means of cover crops, terracing, and reforestation are encouraged. On the other hand, a construction program is now under way for the erection and integrated operation of a series of storage dams on the principal tributaries, and high navigation dams on the Tennessee itself.

The Authority's agricultural experts estimate that a general shift toward improved farming practices throughout the entire valley area would facilitate absorption of an additional four inches of rainfall, a further ground-water storage equivalent to about twice the capacity of the Norris Dam reservoir. This amounts to approximately 6,500,000 acre-feet.

Such storage in the soil is a valuable supplement to the dams, the main instruments of control. On the Tennessee itself, nine high dams and one low-lift navigation lock are contemplated. Of these, three are now in existence—the privately owned Hales Bar Dam located 40 miles downstream from Chattanooga, the war-built Wilson Dam at Muscle Shoals, and Wheeler Dam, at the upper end of Lake Wilson, completed in 1936 by TVA. Four more are under development or actual construction—Gilbertsville Dam at Gilbertsville, Kentucky; Pickwick Landing Dam, 53 miles downstream from Wilson Dam; Guntersville Dam, near Guntersville, Alabama; and Chickamauga Dam, near Chattanooga, Tennessee. Two more dams have been recommended to complete the transformation of the Tennessee from Paducah to Knoxville into a navigable waterway with auxiliary flood control and hydroelectric power values. These are the Watts Bar project near Peakland, Tennessee, and the Coulter Shoals project near Lenoir City, Tennessee—both between Chattanooga and Knoxville.

IN the uplands, to control the flow into the Tennessee, the Authority has built one storage dam, is constructing another, and has proposed a third. Norris Dam, on the Clinch River in northeastern Tennessee, was completed and put into operation during 1936. Hiwassee Dam, on the Hiwassee River in southwestern North Carolina, is in the initial stages of construction. A third high storage dam has been proposed on the Little Tennessee River at Fontana, North Carolina.



Co-ordinated functioning of these monolithic concrete giants will step the waters of the region down through a chain of reservoirs, making them "walk" instead of "run." Integrated operation will make possible 652 miles of year-'round navigable channel, skim the crests off flood waters, produce about 2,000,000 horsepower of electric energy.

Yet all this would be impossible without the work of a small staff of engineers whose duty it is to record with consistent accuracy, the year 'round, how much rain is falling, where it is falling, and how much of it is coming down the rivers of the region.

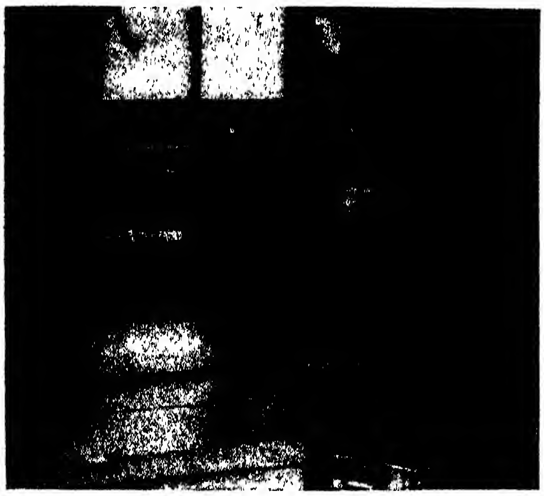
Using as a basis the amount, duration, and intensity of the rainfall, the season of the year, the immediate flow of the river, the average period of surface run-off in the particular area, and the corresponding average period of ground-water run-off, the forecasters are able to calculate the volume of flow in the river as many as 72 hours in advance. They not only determine how much of the rainfall will run off into the river but, if it is an extreme flood crest, when the high stage will arrive at given points along the stream below.

For this purpose, the Authority has located at strategic points throughout the Valley 156 daily gages and 42 recording gages for measuring precipitation. In addition, reports are received from 147 gages owned and operated by other governmental agencies or private corporations. Through the co-operation of the Water Resources Branch of the United States Geological Survey, the Authority receives stream-flow data from about 120 stream-gaging stations located along the Tennessee and its tributaries. By correlation of these data, a continuous record of the total amount of run-off on the land, or in the streams, is made available at all times. To complete the information, stations have been established for measuring the amount of loss through evaporation.

In other words, the question is no longer what effect a heavy rain will have along the Clinch River only, but what effect storms along the Clinch, Holston, French Broad, Little Tennessee, Hiwassee, Elk, and Duck will have on the Tennessee River, and, further, what the combined effect will be on the principal cities and the Authority's construction

projects along the way and in the Mississippi Valley beyond.

"The business is now getting complicated," remarks Albert S. Fry, head engineer in charge of the service, "because we have to estimate the run-off in the drainage basin of each of these tributaries and project our calculations on each flood crest, large or small, as it progresses down to the Tennessee and beyond, determining four or five days in advance just when and where each minor crest will meet others and when the augmented flow will reach cities or points that are not protected against floods."



Above is shown one of the stream gaging stations on the French Broad River. *At the left:* This special radio device announces automatically every two hours whether the river is rising or falling. A similar one broadcasts a record of rainfall

Thus, it is like trying to figure out a time table with many variable quantities, yet that time table is turned out daily. A mimeographed report on river stages, rainfall, and a three-day forecast is sent out daily from Knoxville to about 150 interested parties. The same information is telephoned every morning to the TVA dams and a number of towns on the Tennessee.

Since time is the essence of the system's value, the forecasters are constantly experimenting. Experiments are now under way requiring the keepers at certain isolated gaging stations to report twice daily directly from the stations by short-wave radio. The outstanding developments thus far are two automatic radio reporting devices particularly applicable to river gaging stations too remote for telephone connection. These two, inventions of the TVA, resulted from study of a device used in California by the State Engineering Department for transmitting the fluctuating stages of irrigation canals.

One of these is an automatic streamgage radio transmitter. Because of the unusually rapid run-off from the Elk River drainage area and its almost immediate effect upon the Wheeler reservoir, the first of these automatic devices was set up at the stream-gaging station at Prospect, Tennessee. The principal feature of this equipment is the keying device which takes the gage reading and automatically broadcasts every two hours over a short-wave radio set. The messages, in dot and dash code, are picked up at Wilson Dam and relayed by telephone to the Knoxville office.

The metal float in the gaging station which rises or falls with the fluctuation of the stream is suspended by a small wire cable which passes over a wheel attached to a small drum in the gaging house. The rise and fall of the float, with variations of water level, turn the drum. Around the periphery of the drum are copper electrical contacts corresponding to the water level at any time. These contacts close an electrical circuit and a timing device sends dots and dashes in combinations determined by the position of the drum.

AN observer at some distant point listens in and counts the dots and dashes and from these knows how high the water is at that time. The broadcasting is done at any intervals of time desired. Several of these automatic reporting mechanisms have been installed at strategically important stations in tributary drainage areas.

The second device is a radio rain-recording station which operates somewhat similarly to the automatic river gaging station. There are four of these in operation.

Control was sufficient to justify the issuance on April 30, 1937, of a schedule governing operation of Norris, Wheeler, and Wilson reservoirs for the summer in the interests of navigation and malaria control. For navigation purposes, water would be released from all three reservoirs so as to maintain an average discharge of 17,000 second-feet in the Tennessee at Florence, Alabama. For malaria control—that is, the business of leaving mosquito larvæ high and dry instead of permitting them to thrive in breeding pools along the shores—a definite draw-down schedule was worked out for both Wheeler and Wilson reservoirs. This schedule, of course, would be subject to temporary interruption when necessary by regulation for floods, navigation, or TVA construction operations.

It sounds as though this manipulating of two reservoirs, the combined capacity of which amounts to 1,980,000 acre-feet, were as simple as filling and emptying a water bucket. Yet in July one of those expected interruptions occurred to demonstrate what it takes to control a river.

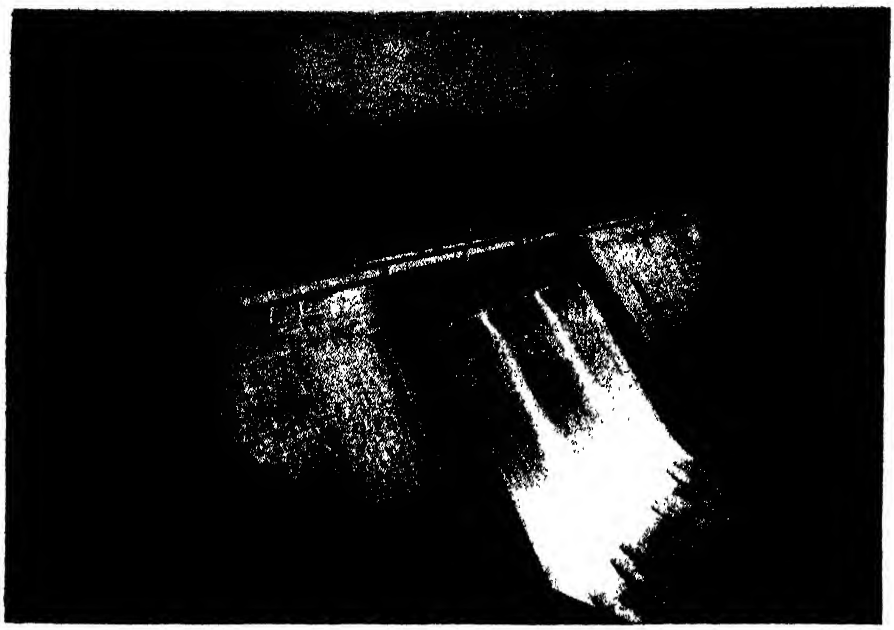
The word came that the engineers were ready to drive the steel for the third cofferdam at Pickwick Landing. This would necessitate reduction of the flow to 8000 second-feet. Then the Eagle Packet Company wrote in from St. Louis that their excursion boat *Golden Eagle* would be coming up the lower Tennessee about the third week of July. Carl A. Bock, assistant chief engineer of the Authority, wrote the packet company as follows:

"Our present plan contemplates discharging 7000 cubic feet per second at Wilson Dam from July 18 to July 22 inclusive. Our records indicate that this discharge will produce a minimum depth of about six feet in the lower part of the Tennessee River.

"At midnight July 22 we plan to increase the discharge at Wilson Dam to 17,000 cubic feet per second. This will produce a minimum depth of about 5.7 feet in the Sheffield Cut and about seven feet at Big Shoals. This increased flow should reach Johnsonville, Tennessee, sometime during Sunday, July 25.

"Six hours before your boat reaches the Sheffield Cut we will increase the discharge to 20,000 second-feet, which will give a depth of about six feet at this point. We will maintain this release until your boat starts down the river on the return trip."

That was the plan, and it left TVA



Norris Dam, on the Clinch River, as floodwaters were being released

keeping three balls in the air at one time —malaria control, flowage control, and navigation. And on top of that it rained.

The forecasters calculated their volumes, nonetheless. Wheeler Lake was drawn down enough to make room for the storage that would occur during the period of restricted flow. This left the mosquito larvæ high and dry. Then the gates were closed, and the engineers drove their steel piling in low water. In final fulfillment, the *Golden Eagle* advanced up the Tennessee and met the increased flows exactly at Johnsonville and the rocky Sheffield Cut as predicted.

In February, 1936, storms in the upper Tennessee basin jiggled stream gage floats up and down like fishing bobs. On March 4, Norris Dam was finished and its gates were closed. The heavy rains continued. Yellow water began to lick about Chattanooga's waterfront. By March 30, the high water reached a 37.1-foot stage, 4.1 feet above flood stage. It is estimated that without the regulation afforded by Norris Dam, the river at Chattanooga would have reached a stage of about 41 feet, with consequent flooding of 1000 acres of urban property and flood damages to a total of approximately three quarters of a million dollars.

A FEW days later the crest, a flow of 318,000 second-feet, reached the Pickwick Landing damsite. But, warned in advance exactly when the crest would arrive, the engineers had had ample time to remove equipment and materials to points of safety.

The most effective example thus far of regulation for flood control occurred during the storms that created the great flood in the Ohio Valley in January, 1937. Rainfall records indicate the following precipitation between December 27, 1936 and January 28, 1937: Memphis, on the Mississippi, 20.49 inches; Johnsonville, on the lower Tennessee, 25.06 inches; Nashville, on the Cumberland, 15.81 inches; Louisville, on the Ohio, 19.94 inches; Cincinnati, on the Ohio, 14.81 inches; Columbus, on the Scioto, 11.66 inches; and Marietta, on the Ohio, 11.52 inches.

Rainfall records for Knoxville and Chattanooga during this period were 12.51 inches and 12.87 inches, respectively. Rainfall in the Clinch River basin during January amounted to 10.83 inches, two and one-half times normal for that month, which is 4.11 inches.

All through this period, Norris Dam stored water, withholding from the Tennessee an average flow of about 32,000 cubic feet per second. The effect was to reduce the flow at Chattanooga by about five feet during the two periods of high water. The first high stage was such as to put TVA construction operations at both Chickamauga and Guntersville dams under water. The second was not quite enough to overtop the Chicamauga cofferdam again, but it kept the Guntersville cofferdam submerged. The forecasting system gave adequate flood warnings on each occasion, so that on each job all equipment was protected and no workmen endangered.

Farther down the river, Wheeler Dam reservoir was being operated in conjunction with that of Norris Dam. Wheeler Lake has a flood storage capacity of 500,000 acre-feet. On the occasion of both high stages, Wheeler reservoir was able to withhold enough from the flow of the Tennessee to permit the cofferdam at Pickwick Landing Dam to escape flooding by inches. Release of water at the dam was allowed to rise to a peak flow of 230,000 second-feet, but no higher, during these crises. This gave the lower Tennessee basin a much needed chance to drain out, as it and the Duck were in the path of the heaviest rains.

The effect of the combined storage afforded by Norris and Wheeler reservoirs on the Ohio River, which during all this time was raging in one of the worst floods in history, was to skim approximately six inches off the crest. The town which perhaps benefited most from this was Cairo. With its levees overtopped by nine inches, Cairo had found it necessary to throw up temporary mud boxes atop its permanent protective structure. The occurrence of sand boils throughout the town gave evidence of the tremendous pressure being exerted upon the city's defenses. It may well be that an added head of six inches against the temporary mud boxes plus the increase in the river's pressure would have constituted the last straw needed to undermine the whole protective structure and inundate the city.

Many persons do not understand how a dam can have more than one use, the general impression in the past being that a dam is usually designed for but one purpose and is located at the site particularly expedient for such purpose. There is a growing recognition, however, that the many uses of water and land are inter-related.

THE greatest total public benefit is not attained through piecemeal development. It is come by through treatment of a drainage basin as a whole, through co-ordinated operation of strategically placed plants. And it is entirely possible that comprehensive development requires fewer structures than piecemeal development. For example, in addition to the existing Wilson Dam and Hales Bar Dam, it would have required 32 low-lift dams to create a navigable channel between Paducah and Knoxville similar to that of the Ohio River. The Tennessee Valley Authority is building seven high navigation dams instead of the 32, with resultant benefits of flood control and water power in addition.

The most economical development of water resources for multi-purpose usage comes only after all pertinent factors are taken into consideration. Temperature, winds, rainfall, topography—these are only a few, yet are indicative of the complexity of the problem. And when one looks at the problem as the development of an entire drainage basin rather than of a single stream, the wisdom of integrated development becomes apparent at once. Interlocking and year-'round navigation are not achieved by a dam here and a dam there. Flood protection is not rendered by low-lift navigation dams or by an occasional storage reservoir in the mountains, which under private operation might release water when storage would be to the public interest. Nor is the maximum of power extracted from a basin's flowage if only the largest power sites are developed and the remaining stream flow left unused.

OUR POINT OF VIEW

Don't Overtax Fuel Oil

As pointed out in the article "The Diesel Broadens Its Field," published in our April issue, one of the factors that may militate against the inherent advantages of the Diesel for many purposes is the cost of fuel. Designed to operate on any ordinary fuel oil such as is readily available throughout this country, the Diesel can supply efficient power at low cost. But, remove the low-cost advantage of the engine, by increasing the cost of fuel, and the recent technological advances in design and construction hold little advantage to the ultimate consumer.

It has frequently been stated that there is small reason to fear that the producers of fuel oil will raise their retail prices merely because of increased demand. The insidious and insatiable monster of unfair taxation is the hidden receptacle into which will pour the added costs of fuel oil, unless consumers are wary, keep in constant touch with developments, and nip efforts at increased taxation in the bud.

A case in point is the recently defeated Boland fuel-oil bill, aimed to levy a tax of 42 cents per barrel on all fuel oil used in the United States for the generation of heat or power--a *one cent per gallon* tax over and above present taxes. It is estimated that fuel oil retails at an average of a little more than seven cents a gallon, of which, at the present time, an estimated two thirds of a cent per gallon go for indirect and hidden taxes. In addition, three states levy sales taxes ranging from one quarter to one cent per gallon. Thus, the Boland bill, if passed, would have increased taxation over 100 percent on a commodity that is vital to the prosperity and comfort of millions.

Just because this bill has been defeated is no reason for its opponents to rest on the oars. Similar measures will come up in the future—the very near future, if the avariciousness of the tax grabbers has not changed overnight. In fact, just prior to going to press, one congressman (from a *coal* producing section of the country, and before a convention of *coal* merchants!) has pledged a steady fight for a federal law to tax fuel oil one cent a gallon.

Fuel oil is not a luxury, and therefore should not be subjected to discriminatory taxation, striking largely and directly at home owners who, in one year, use approximately 100,000,000 barrels of fuel oil for home heating. Furthermore, only upon such a low-cost product can be based many future developments in heating and power, as well as in the field of chemical research. Remove the advantage of low cost and immediately there is removed much of the incentive for development. Aside from any questions of discrimination and class taxation, the money-mad tax grabbers must not be permitted to strangle, for their own selfish ends, the progress of scientific research and its benefits to the world at large.

We Can Laugh—Now

How simple hindsight is, and how accurate, but how precarious is any attempt to predict the future! Recently this fact was brought home to one of the editors of this magazine when he repaired to a roentgenologist to have his alimentary canal studied by X ray. As he lay comfortably under a fluoroscope with a seated physician calmly watching his "innards" perform for a while, his thoughts reverted to a statement which he had recently blundered across, written just after Prof. Roentgen's discovery of the X rays. "When the details reach us," it read, "the process will probably prove to be of a scientific rather than of practical interest."

Not of practical interest! Some long-gone writer "stuck his neck out" that time, did he not?

New Minds For Old

The "good old days" may constitute the substance for considerable romancing on paper and in the mind; but thinking of them too much very definitely is not conducive to progress. You may, according to Charles F. Kettering, vice president of General Motors in charge of research, have either an old or a young mind, one that looks backward too much —"our whole education is based on looking back on what has been done"—or one that has "got the essentials of optimism" and looks forward with consuming curiosity toward what is yet to be done and will be done.

Mr. Kettering rightly says that there always has been too much of the brand of pessimism which is dubious of the future, and he believes that such thinking of "old" minds retards progress. When the Rosetta stone made possible translation of Egyptian hieroglyphics, he says, the first tablet read bewailed the high cost of living and wished for the good old days. He cites the first issue of Scientific American as arguing the question whether the telegraph would ever be a success (but, unfortunately, did not add that *that* was in 1845). When we got the telephone so that we could talk 100 miles, and again when we could talk 1000 miles, people asked: "Why should you wish to talk farther?" Old minds they had—old minds afraid of the future, Mr. Kettering says.

To these examples and others he gives, we might contribute two from a lecture by Dr. Royal N. Chapman, director of pineapple research in Hawaii, which was recently quoted by Joseph T. Mackey, president of the Mergenthaler Linotype Company. About 1880, a Belgian banker, M. Piermez, said: "It is not likely that there will be again an economic progress comparable with that by which this century has changed the world." The prize came in 1886 when United States Commissioner of Labor C. D. Wright decided in his first report that the world had enough railroads, canals, international communications, and merchant shipping, and added that all that was left for society to do was to settle down and enjoy the fruits of its labors because the next 50 years would see no advance equal to the previous 50 years. Dr. Chapman chuckled when he had quoted this, and then imagined an assemblage of youngsters in 1886 listening to the above-mentioned oldsters.

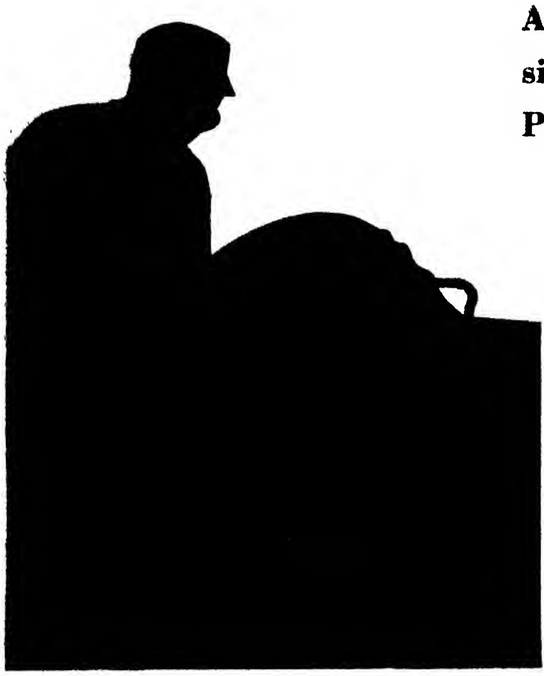
In that audience would have been Edison, aged 39; Albert Michelson, 34; Ford, 23; Steinmetz, 21; Thomas Morgan, 20; Madame Curie, 19; Millikan, 18; Orville Wright, 15; Marconi, 12; Kettering, 10; Einstein, 7; Irving Langmuir, 5. The two Compton brothers had not yet been born.

"Nowadays even the man in the street knows better than to say 'It can't be done,' for he believes science can work any miracle," we said in a recent editorial. The statement is quoted here, not to imply that people are more hopeful of the future than Mr. Kettering believes, but to emphasize our belief that they are generally open-minded because they have listened to a few leaders such as he, and are willing to be shown. They, however, are the spectators, not the doers. It is those who make progress of one kind or another who are most to be chided for living and doing so close to one restricted channel that they lose perspective on the whole picture. It is those in high places who have their pet theories concerning the "social implications of science," "science holidays," and the like who tangle the threads of progress and cause bewilderment. The young ones with the young minds are too busy to listen to such talk and haven't so much to unlearn.

GRITS FOR GRINDING

Abrasives Important to Industry . . . Make Possible Improved Grinding, Lapping, Polishing, Precision Work . . . Abrasive Research Goes On

By PHILIP H. SMITH



A shower of sparks flies as a workman removes casting gates and risers with a large grinder

THERE was a time, not so long ago, when automobile engine bearings had to be taken up after about 15,000 miles of service. Today, the motorist seldom gives a thought to bearings. He expects fine performance for an indefinite number of miles and gets it because the automobile is the beneficiary of progress in the field of abrasives.

It is probable that the motor vehicle owner has a mechanical refrigerator which he may not class as a piece of fine mechanism, but from which he expects performance as dependable as that given by his car. Here, too, he gets excellent service day in and day out because modern abrasives permit manufacture of precision parts at low cost.

Labor-saving machinery, which characterizes this modern age, depends heavily upon grinding, honing, and lapping—all operations employing abrasives in some form—and industry, too, benefits directly. Abrasive wheels having the capacity to cut through one-inch steel bars in a few seconds have recently revolutionized the production cutting of many materials. Metal working plants use abrasive wheels for grinding, cutting, and polishing; so do the stone, ceramic, and jewelry industries. Stone monuments are cut, polished, and even lettered with abrasives. Such varied products as metal foils, flour, paint, textiles, and sugar, all require rolls in their production and the rolls require grinding for fine surface finish.

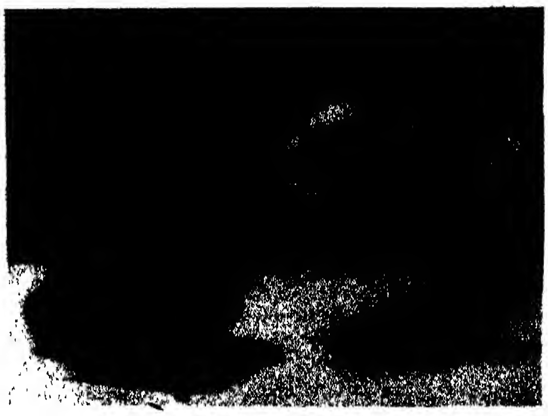
Research made the abrasive industry what it is today. Indeed, you will have to hunt far to discover a single business in which it has played so vital a rôle. When Edward Goodrich Acheson made the first carbide of silicon in an electric furnace some 40 years ago, he did more than develop a new abrasive; he established the precedent of the scientific approach from which the industry has never departed. We can appreciate this discovery now as a momentous occasion because it launched the break-away from natural abrasives and inaugurated the era of the synthetic or artificial. Had industry been forced to remain dependent upon the natural with all its lack of uniformity we could not boast today of fine finish and close tolerances in mass production. It took the slow substitution of artificially created materials which could be controlled as to nature and performance to make abrasives the handmaiden of mechanical precision.

THIS matter of control is important to an understanding of what abrasives are, what can be accomplished with them, and where developments are likely to lead. Control is what has enabled the manufacturer of abrasives to meet industrial needs as fast as they have been generated. It explains the great variety of abrasives in use today and hints that there are more to come.

One can appreciate best what this control means by stopping to think of the range of products which are handled with abrasives and then consider the abrading action itself. Slitting a fountain pen point with a gap .006 of an inch wide, removing the heavy gates from steel castings, and grinding pulpwood for paper making, are all distinct operations if for no other reason than that the materials are quite unlike. Each material offers a different resistance to the abrasive and the abrasive must be able to "take it." Control of abrasive manufacture, therefore, must begin with the basic ingredients and be maintained throughout the process in order that the shape and toughness of the grains may be pre-determined.

Two artificially made products—silicon carbide and aluminum oxide—are the mainstay of abrasives. The former is made by the electric furnace reaction of silica sand and coke; the latter by the fusion of the mineral bauxite. When these products come from the furnace they must be crushed to form grains and a second control established by careful grading for size.

If an abrasive is to be used in wheel form, another problem presents itself

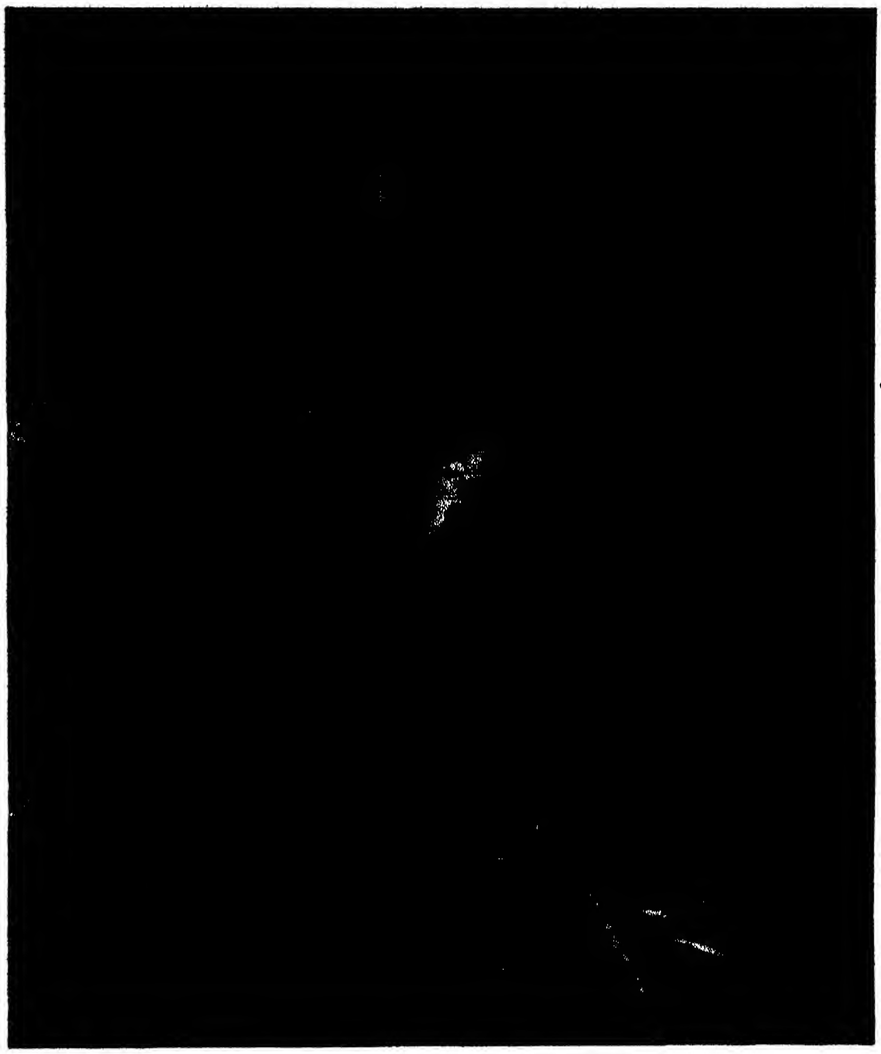


In contrast to the above photograph, a tiny high-speed hand grinder touches up a casting

over which control must be imposed. The grains must be bonded together so that their cutting edges will do the prescribed work, and the bond must be so made as to regulate the rate of wear. If the bond wears away faster than the grain, the wheel will appear soft and wear down at an excessive rate; if the grains break down more rapidly than the bond, the wheel will

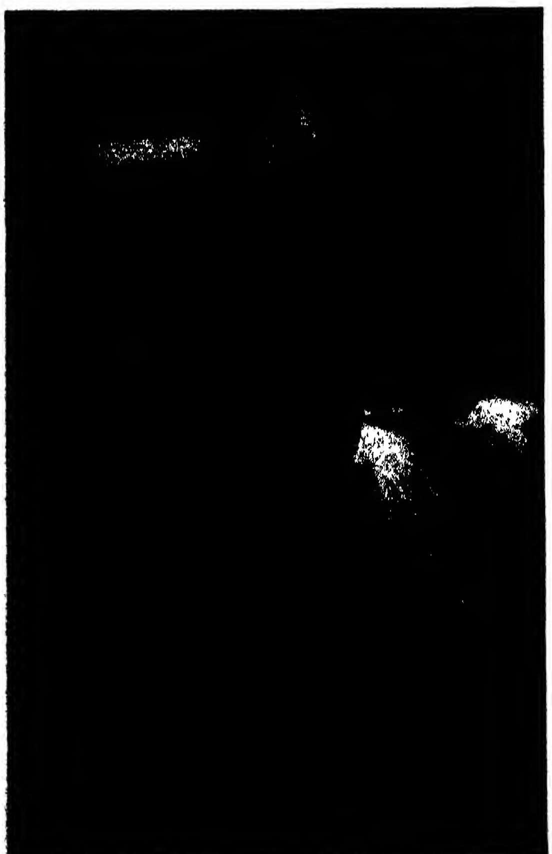
glaze and cut poorly. Bonds, therefore, must be controlled with respect to type and amount according to the character of work to be performed. The bonds may be made of vitrified clay, sodium silicate, resinoid, rubber, or shellac. Finally comes a fourth factor which controls the size of the pores between the cutting grains to provide clearance for the chips removed in grinding.

Countless examples of grinding practice can be taken from the automobile industry where it has been carried to a fine art, but instead let's look at the manufacture of the household refrigerator where the human hair, with its .003 of an inch diameter, is no longer fine enough to measure tolerances. In the production of compressor crankshafts, one manufacturer is grinding them at the rate of 40 an hour, holding to limits of .0003 of an inch plane and .0005 of an inch diameter. Another producer is holding to limits of .0001 of an inch in the grinding of the face of a small rotor.



A grinding disk does a speedy job of cutting off sections of tubing

SUCH fine tolerances under mass production methods are a development of no more than six years. They are possible only because abrasives and grinding equipment have been refined to a point where they will duplicate operating results quite irrespective of human skill in the operation. To grind piston pins within a tolerance of one-fourth of a thousandth of an inch at satisfactory production speeds, for example, requires the use of wheels that are new and distinctive in grit sizes and bonds. Not only must the grit be graded for size with extreme care, but it must also be controlled with regard to crystal shape and structure, while the machine must grind with accuracy down to the last finishing pass where the stock removal is infinitesimal.



This high-speed floor-stand wheel does a rough grinding job on an irregular casting

Operations of this kind which involve the use of highly refined equipment are often termed lap grinding. It carries precision in grinding to a point where the older requirement of a finishing lapping operation is frequently unnecessary. Rolls for finish transfer to sheet or foil are now rarely lapped, while lapping has been largely eliminated on practically all cylindrical, centerless, and some internal and surface-grinding operations.

Similar refinements have been made in honing tools and the abrasives used with them. Boring and reaming operations now produce accuracy in motor bores and finishes hitherto undreamed of on a production basis. Special abrasive honing tools have been developed for the honing of crankshaft pins and journals which produce bearing surfaces that eliminate running-in time, while the honing of splines for closer fits and accuracy has provided mass production with a new technique.

As grinding technique has improved, so has the science of lapping. Abrasive grains are now graded in size to minute powders under microscopic control and new carrier mediums or vehicles have been developed. Industry now has at its command new compounds which are unaffected by temperature changes as were the older greases and oils; vehicles which hold grains uniformly separated; which control the speed of cut to prevent deep grain marks; which are non-corrosive and do not require special cleaners for removal. These compounds are widely used in the lapping of gears, worms, machine tool spindles, slide and rotary valves, to mention only a few applications. Lapping operations

also have been developed for handling soft metals such as bronze or babbitt, while fine compounds are now available for metal polishing where buffing wheels are not suited.

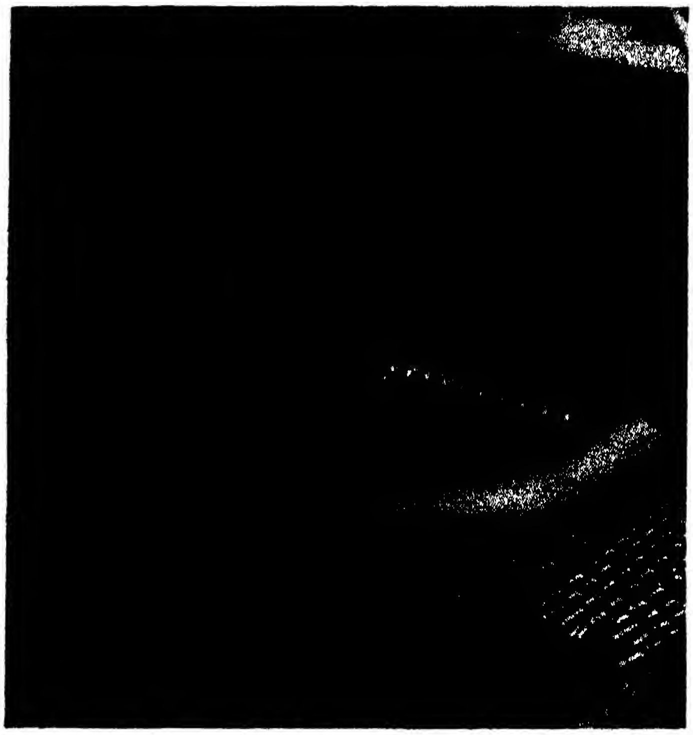
Occasionally a new development appears which taxes the ingenuity of the abrasive manufacturer. The advent of cemented carbides was such a case. When tool tips of this extremely hard material came into use, there arose a need to grind them to keep them sharp. Special brittle or friable grades of silicon carbide and new bonds were employed to produce a vitrified wheel, and while results in general were satisfactory, the operation was slow and cutting edges on the ground tools frequently had to be lapped or highly finished to give maximum efficiency.

STILL further development led to a wheel employing diamonds as the abrasive, in a synthetic resin bond. Despite the higher cost of the diamond grits, the initial expense was offset by savings in labor, the extended tool life between grinds and the savings in scrapped tools due to the generation of less heat. In most cases subsequent lapping operations were eliminated.

Diamond wheel operations have proved particularly satisfactory on multiple point tools such as milling cutters, where they promote extreme accuracy and better finishes. What this new wheel means in time saving may be gleaned from the following examples: 12 piston grooving tools ground in 12 minutes as contrasted with six hours using a vitrified wheel. Since a lapping operation followed the use of the vitrified wheel the total time by this method was 30 minutes per tool as contrasted with one minute with the diamond wheel. The grinding of one work rest blade provides another example. Here the diamond wheel took five minutes; the vitrified wheel, 30 minutes.

The foregoing illustrates with peculiar clarity the scientific nature of abrasive manufacture. The bonding of diamond grits with a resinoid involved more than using one laboratory product—resinoid—to handle another, the cemented carbide. Phenolic resins came into use because of the accumulated knowledge of what was required to make satisfactory bonds. The chemist had already formulated relationships between abrasives and bonds in respect to wear and heat generation and he was able to seize upon the new material because it permitted manufacture of a free and cool cutting wheel.

One is accustomed to think of an abrasive in wheel form strictly as a tool to machine a surface by grinding, but abrasive wheels are also used for sawing. In the past few years so-called cut-off wheels have come into very wide use in industry. Originally employed for the cutting of metal stock which could not be handled with a steel saw, the trend has been toward cutting-off a vast number of softer materials where high production rates called for faster cutting time and lower cost. Comparative studies between cutting bar stock with a power hack saw and an abrasive wheel have shown reductions as high as 20 to one. Then, too, there is the added advantage that the cutting leaves smooth, parallel faces, requiring no further machining.


A skilled workman polishes an augur on a grinding wheel

Cut-off wheels look like phonograph records and are so designed that the abrasive points on the periphery simulate the teeth of a saw. The thousands of little cutting teeth actually cut rather than "burn" through, as one might expect. Both silicon carbide and aluminum oxide abrasives are used, and the bonds are, variously: shellac, rubber, and resinoid, according to intended use. If you want to cut off agate or ivory you would use a shellac-bonded wheel, while pen points or tungsten rod would require a rubber bond.

It was the advent of the synthetic resin bond which really put the cut-off wheel on the industrial map. It made possible the increase of wheel speeds from 9000 to 16,000 surface (peripheral) feet per minute, and that is the difference between non-economical and economical cutting speed for a number of materials. One manufacturer found he was able to save ten dollars a day by using the cut-off wheel to cut 1-inch steel tubing required for furniture production. Other producers report savings of 65 to 85 percent in cutting high speed steel, tool steel, and cold rolled steel. Resinoid-bonded diamond cut-off wheels as thin as .020 of an inch are being employed successfully to cut off tool tips from solid bars of cemented carbide.

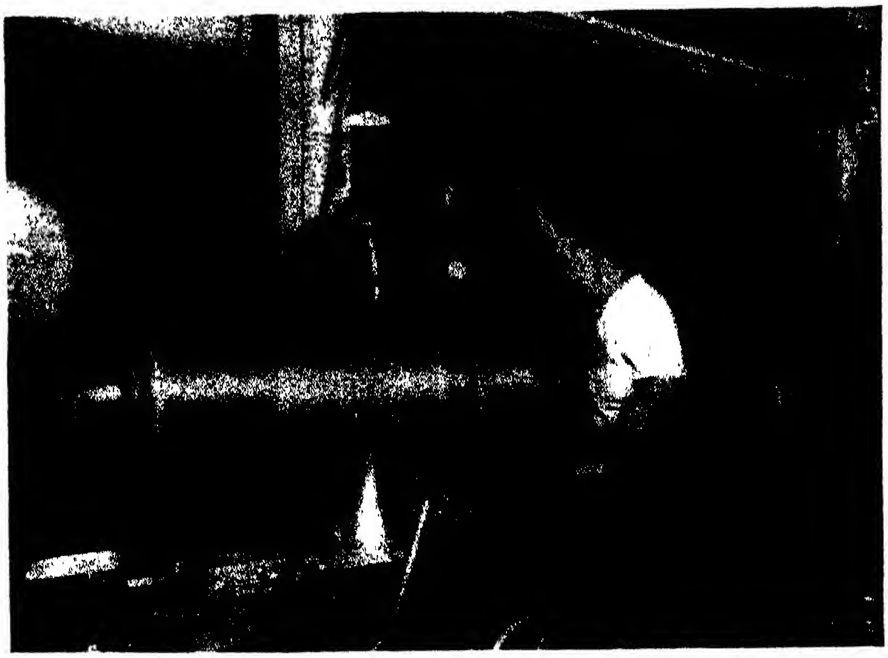
Rubber-bonded wheels are now commonly used for submerged or wet cutting, which are developments opening the way for cutting off many materials which hitherto could not be so handled because of the damage from heat. Thus we find glass rod and tubing, plastics, and heat-sensitized steel being cut with ease, while metallographic specimens cut by the submerged process require less final preparation.

Abrasives appear in still other bonded forms which are called, as a group, mounted wheels and mounted points. These mounted abrasives are made in a great variety of special shapes, but all are very small in size and, as a rule, are used with portable machines. The development of machines with rated spindle speeds of 60,000 to 65,000 r.p.m. have made these small diameter wheels and points both effective and efficient grinding tools and we find a rapid growth in their use. Where it is necessary to remove surplus material from dies and molds, these abrasives work much faster than any hand filing, scraping, or chiseling. Aside from strictly industrial use in foundries, die shops, pottery plants, and many other establishments, these newer abrasives have proved a boon to the craftsman with a home workshop.

THE scientific control over all stages of manufacture which has been responsible for fitting the abrasive to the job, has been applied to the making of coated abrasives (sandpaper) quite as much as to wheels. Flint, garnet, and emery are still employed but the artificial abrasives are used more extensively. Improvements in sandpaper are mainly in method of application rather than in the materials themselves, although treatment of the grains to obtain uniformity of size and hardness is given to coatings quite as much as to bonded materials. By far the most striking development of

recent years is the coating of paper and cloth by an electrostatic process.

It can be understood readily that grains dropped upon a glued surface will fall in haphazard manner and that there will be no uniformity in arrangement of the cutting points, which, after all, do the work. To overcome this weakness, the electrostatic process was devised. It works this way: During the process of manufacture, the coating takes place in a powerful electrostatic field which charges each grain to make it stand point up. Likewise, the electric force spaces the grains equi-distantly because every grain having a like charge repels every other grain. When one learns that the number of grains per square inch of surface may run as high as 609,000, it is obvious that the electric force does a very neat job of regimentation. The accomplishment is reflected in increased efficiency to be had from the coated material, estimated to run from 20 to 50 percent according to the character of the work.

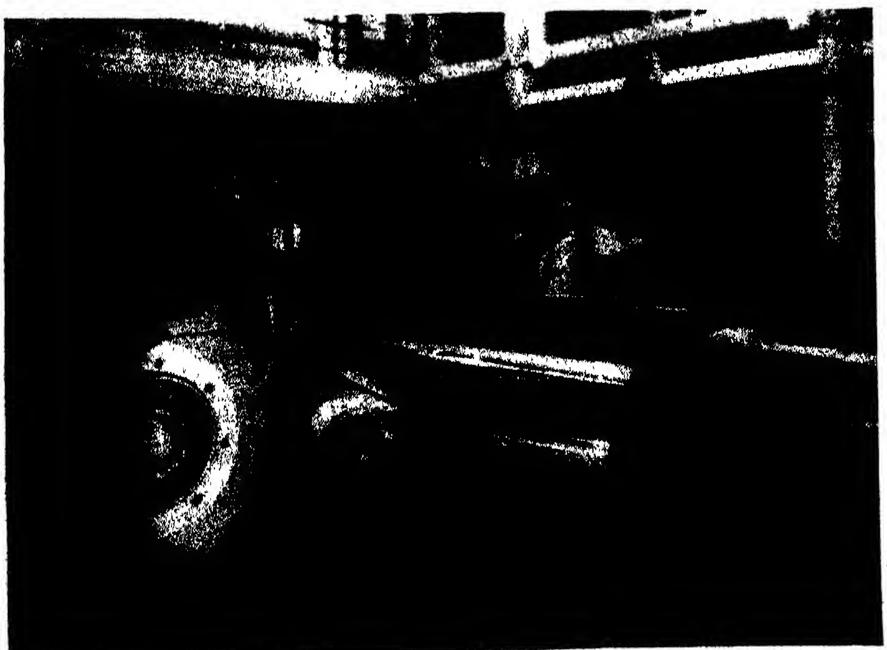


Hand-wheel control on a machine for grinding rolls

One might reasonably ask what there is left to be developed now that so high a degree of control has been established in the abrasive arts. Is even greater manufacturing control possible or desirable? The men most responsible for accomplishment thus far would say that much remains to be done.

The history of abrasives is a story of keeping abreast of other technological gains. New materials have created the demand for new methods of fabrication and that course is by no means run. An age that calls for greater speed and continuous refinement of mechanical devices imposes new demands on materials and methods. Materials must be lighter and stronger and better means must be found for fabricating them.

Between silicon carbide and the diamond there is a great gap in the scale of hardness—a gap which the abrasive chemist would like to fill. A few years ago he thought he had it in boron carbide, second only to the diamond in hardness. This material is made in an electric furnace from coke and boric acid, two inexpensive and commonplace materials. The fact that a way had been found to eliminate the free graphite present in large amounts and thus to make a product of high purity, coupled with the fact that it was self-bonding, gave high hope that it could be molded into wheels to grind such tough materials as cemented carbide. These hopes were dashed when it failed to perform properly in wheel form, but it did go immediately into use as a lapping abrasive to replace diamond dust. Today, boron carbide is employed for lapping both cemented carbide wire-drawing dies and flat tools of the carbide, and by lapidaries for cutting and polishing gems.



A mirror-like finish is given to a cylinder by special grinding wheels

Mention that boron carbide can be molded into form leads directly to another phase of the abrasive industry. Abrasives by their very nature are wear- and heat-resistant. They are, therefore, used to fight wear and heat. Boron carbide, for example, makes an excellent thread guide, pressure blast nozzle, and extrusion die for porcelain. Silicon carbide and aluminum oxide in the form of crystalline alumina have wide use as refractory materials, while the latter, bonded in rubber, makes safety stair treads.

If there are any doubts as to what abrasives mean to industry they are cleared up immediately by imagining our industrial civilization dependent upon nature's rock and stone. Without abrasives we would have to go back to the buggy and all that went with it. Almost everything connected with this industry comes from research and is primarily Twentieth Century. The abrasives, the electric furnace that produces them, the resinoids that bond them together in wheel form, were not conceived by nature but by man. The "can't be done" has been accomplished by considering the most minute grain, studying its chemical composition and atomic structure and learning to manipulate the grain at will. By acquiring understanding—the highest type of research—a reservoir of fact has been accumulated which promises to yield still greater benefits to industry.

Photographs and data courtesy: The Carborundum Company, The Fellows Gear Shaper Company, Landis Tool Company, Norton Company.

NUMBER ONE ROCKET MAN

A Silhouette of the Shy Massachusetts Physicist Who Pioneered in Rocket Research . . . Much to His Distress He Broke into the Noisier Newspapers

By G. EDWARD PENDRAY
Past President, the American Rocket Society
Editor of *Astronautics*

ON a flat, dry plain, 18 miles north of Roswell, New Mexico, rises a 60-foot tower of steel that has roused more curiosity, and has probably had a greater influence on the future of the world, than any other feature of all New Mexico's arresting landscape.

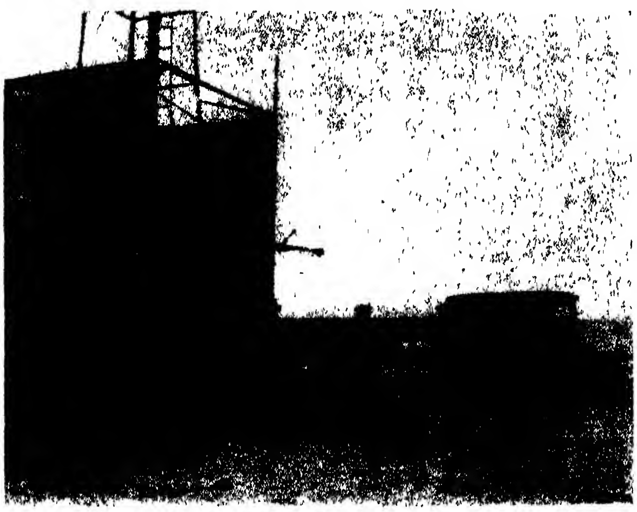
From this tower, at irregular intervals, a Massachusetts physicist and his assistants send roaring into the skies certain gleaming, cigar-shaped projectiles of metal, powered by gasoline and liquid oxygen, and landed by parachutes.

The physicist is Dr. Robert Hutchings Goddard, a bald, spare, pleasant man who will be 56 years old next October 5 (1938). Rocket experimenters the world over recognize him as their Number One man. Not only has he made more contributions to the new field of rocket engineering than any other one individual, but it was Dr. Goddard who launched modern rocket research with his clear presentation of the possibilities of rockets, both their limitations and advantages, 19 years ago. His publication, modestly entitled "A Method of Reaching Extreme Altitudes," was published by the Smithsonian Institution in 1919.

DR. GODDARD at that time had already been a rocket experimenter for nearly ten years. His first trials were made during some studies of the upper atmosphere while he was an instructor at the Worcester Polytechnic Institute, in 1909. Baffled by the uncertainty and limitations of sounding balloons, he imagined that by building some kind of huge skyrocket he could shoot self-recording instruments high into the stratosphere and bring back information of value to science.

This idea of reaching high altitudes with rockets was by no means new with Dr. Goddard. In fact, we are told that a certain Chinese mandarin in the 13th Century sought to lift himself to the moon by fastening rockets to the legs of his chair. Cyrano de Bergerac, the novelist, wrote a story 300 years ago in which the hero transported himself by rocket power. Warmen saw in rockets a potential carrier of explosives centuries ago, and in the Napoleonic wars rocket brigades blossomed in Europe. In the siege of Boulogne, the English succeeded in setting the town afire with rockets designed by Sir William Congreve.

But those early efforts were rule-of-thumb procedures, and really came to little. What Dr. Goddard proposed, 29 years ago, was to apply the methods of modern engineering to the construction of rockets. He perceived that several diverse and complicated problems would have to be tackled, seriatim: (1) the fuel, (2) the materials, (3) the methods of feeding the fuels, (4) the aerodynamic design, (5) control in flight, (6) the further unknowns.



A rocket being placed in the 60-foot launching tower on the plains 18 miles north of Roswell, New Mexico

For the rocket, though a seemingly simple device, is really very complicated. It works by recoil—by application of the ancient principle that every action has an equal and opposite reaction. The action is produced by rapid combustion and simultaneous ejection of gas at high velocity. The reaction occurs in the body of the rocket, which flies at an accelerated rate in the direction opposite that of the ejected gases.

Had Dr. Goddard been a less practical man he would have been content to write an article about the idea, or give a lecture on it, and sit back to await the development at someone else's hands. But it happened that he was of the sort who undertake to test their notions before they talk about them. The only successful examples of rockets in his day were skyrockets and life-saving rockets—both powered by modified gunpowder. Beginning at this point, Dr. Goddard tested powder fuel rockets. As new teaching appointments took him to Princeton, and then to Clark University, the idea went with him.

Talk of rockets is so commonplace today—such success has attended the efforts of experimenters—that rocketry is almost respectable. But in the old days of 1914 and earlier, few sane engineers spoke of them except humorously, and physicists who entertained the idea of rocket transportation must have been as rare as one-armed flute players. Nevertheless, Dr. Goddard succeeded, one by one, in convincing his colleagues. In 1914, plugging away on his own, he took out two basic patents on rockets, pertaining to combustion chambers and nozzles. A short time later he talked the problem of rocketry through with Dr. Charles G. Abbot, Secretary of the Smithsonian Institution. So convincing was his argument that the conservative old Institution agreed to grant him modest funds for a series of experiments. In the tests that followed, Dr. Goddard demonstrated that rockets really need no air to push against, and that they are capable of development. He also proved that gunpowder-like fuels must be abandoned in favor of more powerful, more easily controlled kinds, probably liquefied gases.

Thus started what rocket engineers now refer to as the era of "liquid-fuel" rockets—the real beginning of scientific rocketry. Simple calculations show that the most powerful release of energy, pound for pound, occurs during the combustion of carbon or hydrogen with oxy-

gen. The problem was to produce this combustion at the right time, in the right place, and under the right conditions.

After some preliminary trials, Dr. Goddard decided that the best fuel would be a chemical combination of hydrogen and carbon, as in gasoline, and that oxygen could most conveniently be supplied in the pure form, liquefied. These early tests were carried on very secretly near Auburn, Massachusetts, and apparently were the first "proving-stand" experiments with liquid-fuel rocket motors —primitive, to be sure, but they set the foundation upon which a great deal of experimental work has since been built. Dr. Goddard tried out liquid oxygen and various members of the hydro-carbon series, including gasoline, kerosene, liquid propane, also ether. He finally discarded the others and settled on gasoline and oxygen. Virtually all of his experiments since have been made with these.

By 1923 he felt ready to try an actual liquid-fuel rocket. On November 1 of that year he completed and tried out a small one on his proving-stand, tying it down so it couldn't fly. It seemed promising, but wasn't good enough. For one thing, there was the problem of getting the fuels from the tanks into the combustion chamber fast enough. He had used small pumps on the rocket, but pumps are slow, heavy, and troublesome.

Professor Robert H. Goddard, "Number One Rocket Man," in the well-equipped shop three miles from Roswell, New Mexico, where his rockets are prepared

It took two more years to overcome that problem. In December, 1925, he completed and tested a second liquid-fuel rocket in which the fuels were forced into the chamber by the pressure of an inert gas, nitrogen. This method worked well, but still the experimenter cautiously denied himself the experience of turning it loose to see it fly.

That pleasure was reserved until three months later, when on March 16, 1926, at Auburn, he put an improved liquid-fuel rocket into his improvised launching rack and let her go. So far as I have been able to find evidence, this was the first actual flight of a liquid-fuel rocket in this country or anywhere in the world. It was in no sense a public shot. The only witnesses were Dr. Goddard and a couple of helpers. The experimenter timed it with a stop watch and later reported that it fired for two and a half seconds, during which time it flew 184 feet, "making the speed along the trajectory about 60 miles an hour."

A queer-looking rocket it was, too, compared with the sleek projectiles Dr. Goddard's shop in New Mexico now turns out. The fuel tanks were slender tubes, placed one behind the other. The motor, consisting of the combustion chamber and its exhaust nozzle, was well ahead, supported on spidery arms which also carried the fuel lines. The whole contrivance was about ten feet long, but only about half of this length was actual rocket; the rest was the harness that joined the motor to the tanks. Pressure to force the fuels into the combustion chamber was furnished by an outside pressure tank and, after launching, by an alcohol heater carried on the rocket.

The idea of putting the motor ahead of the tanks was the mistaken one that this method of "pulling" the rocket, instead of pushing it, would make it fly better. In practice it did nothing of the kind; it only added to the difficulties of construction. Dr. Goddard abandoned the design at once in favor of rockets with the motor at the rear. Between 1926 and 1929 he shot a number of these, with varying success.

And then, quite unexpectedly, Dr. Goddard broke into the newspapers—much to his distress. Naturally reserved and somewhat uncommunicative, he had early discovered what most rocket experimenters find out sooner or later—that next to an injurious explosion, publicity is the worst possible disaster. (Most newspaper writers still seem to believe that every rocket is aimed at the moon.)

It was his shot of July 17, 1929, at Auburn, that brought Dr. Goddard this great and unexpected burst of notoriety. The rocket was a fairly large one, carrying a small barometer and a camera. Being large enough to carry instruments, it also made a great deal of noise. Neighbors telephoned the police that an airplane had crashed in flames. A few excited Auburnites were certain a meteor had fallen. When fire and police departments arrived, they found only a rocket experimenter, examining the remains of his rocket, pleased at the notable fact that his instrument, shot several hundred feet heavenward, had parachuted gently back from the flight and landed intact.

But the simple facts were by no means enough for the newspapers. Some, of course, had sensible stories, but they were in the minority. It was widely reported that he had shot a rocket to the moon, but had failed, that his rocket had exploded, that it had contained tons of explosive, that his intentions were to fly to Mars.

Fortunately the flurry was short-lived. Also, it had some good results, for it is said that as a result of the publicity Col. Charles A. Lindbergh first became interested in Dr. Goddard and his rockets. At any rate, it was in 1929 that the flyer brought rocketry to the attention of the late Daniel Guggenheim. The result was a grant that made possible the present establishment in New Mexico, under conditions that many experimenters consider ideal for rocket research.

About three miles north of Roswell, a shop 30 by 55 feet was erected, and near it a 20-foot tower built for proving-stand tests of motors and rockets. Fifteen miles farther north, on the plains, stands the 60-foot launching tower from which actual rocket shots are made. The region

thereabout has an altitude of about 3500 feet—enough to reduce noticeably the resistance of the air to rapid flight, as compared with the denser air at sea level. The country is level and open. There is space for high experimental flights without much danger of the rocket landing on an indignant bystander.

Gasoline and liquid oxygen, mixed, form a peculiarly violent detonator, yielding about five times as much energy pound for pound as TNT. Dr. Goddard has taken what may seem like extreme precautions against accident and injury. At the launching tower, all experiments are managed by remote control. The operator and observers are stationed 1000 feet away, in a shelter protected by sand bags on the roof. The observer whose task it is to clock the rocket flight, and who therefore cannot conveniently work from a shelter, is stationed 3000 feet from the tower. For close observations, to watch the firing, launching, and so on, there is a concrete dugout 50 feet from the launching tower. The observer looks through four-inch peepholes in a tilted slab of concrete three inches thick.

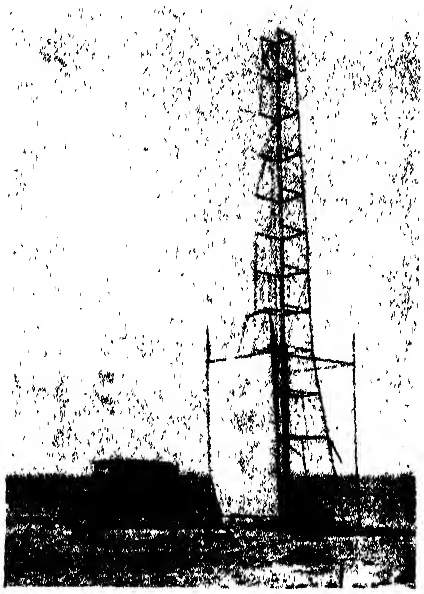
THE rocket motor used by Dr. Goddard in his New Mexico shots is 5¾ inches in diameter and weighs five pounds. It usually fires about 20 seconds, and delivers a maximum thrust of 289 pounds. Such a motor can hoist a real projectile into the air, and such, indeed, have been the projectiles that Dr. Goddard has been attaching to them. His first New Mexico rocket was shot on December 30, 1930. It was 11 feet long and weighed 33.5 pounds without fuel. It reached an altitude of 2000 feet, and a maximum speed of 500 miles an hour.

This was only the beginning. Heavier, more powerful rockets were to come. In August, 1934, the experimenter shot a pendulum-controlled rocket that made an altitude of 1000 feet, then turned horizontally for 11,000 feet, landing a little over two miles from the launching tower. At one point its velocity touched 700 miles an hour.

In none of these shots was altitude or speed the chief object. The experimenter, having tentatively solved, in order, the problems of fuel, material, methods of feeding the fuel, and aerodynamic design, was by now working on the hardest knot of all--control. Specifically, he was trying to build a rocket that would be capable of sure, dependable upward flight. After 25 years of experiment his eyes were still on the stratosphere.

Now there may be some trick of aerodynamics or design that will guarantee vertical flight without special control mechanisms and the extra complications they entail. Many rocket experimenters hope so, but to date they haven't discovered it. After his early experiences with cantankerous projectiles, whishing through the air at express speed but following whimsical air-paths all their own, Dr. Goddard decided that a gyroscopically-operated control mechanism would have to be devised.

In the beginning he tried some other devices, notably the pendulum, but these depend on gravity and are affected by the course and acceleration of the rocket. The gyroscope, however, holds its position with relation to space, regardless of the torque or acceleration of the projectile carrying it.



Erection of the 60-foot launching tower formerly employed in the east

The main problem was to construct a sensitive servo-mechanism that would steer the rocket back on course without disturbing the gyro. Dr. Goddard's idea was to have small vanes pushed into the path of the exhaust gases in such a manner as to deflect the flight. In his first trial the system didn't work as well as expected. The performance led the physicist to suspect that the vanes were too small, and he resolved later to try again with larger ones.

The improved system worked better. The vanes, driven by gas pressure into the rocket exhaust stream, were set to apply controlling force when the axis of the projectile deviated as much as 10 degrees from the vertical. The finest shot so far reported with this system reached an altitude of 7500 feet. Rising slowly from the launching tower, the rocket undulated from side to side as the gyro-control continually corrected the course. "The first few hundred feet of the flight," reported the experimenter, "reminded one of a fish swimming in a vertical direction." After the rocket had gained more speed, the curves smoothed out.

Such a flight, of course, is not ideal. Much power is lost in useless undulations. But flight control had at least been started, and the physicist of Worcester could check off one more step in the series of conquests leading to the development of the rocket. Still before him are those problems classified as "the further unknowns." One of them is the problem of reducing the weight of the rocket, for every extra ounce requires extra fuel to lift it, and extra fuel to lift the extra fuel, *ad infinitum*. There are no filling stations on the route to extreme altitudes. The rocket must start with a full tank, and one filling is all it can expect.

Other problems are those of improving the efficiency of the rocket motor, which is still far from that which is theoretically expected; improving the aerodynamic design for flight at super-sonic velocities; smoother control; and a surer technique for releasing the parachute or other landing apparatus at the exact top of the flight.

IN justice it should be said that Dr. Goddard is no longer alone in the colossal task of mastering these difficulties. All over the world, since 1928, rocket societies and rocket experimenters have sprung up, some to make a few tests and drop the subject, others to plow on toward the goal as doggedly as does Dr. Goddard himself. In this country there are at least 20 other active experimenters, and a rocket society that numbers nearly 300 members. In England an experimental group has about 50 members. There are rocket experimenters in Austria, Russia, France, Japan, New Zealand, Canada. The American Rocket Society has an active affiliate at Yale University. Other American universities are considering the establishment of affiliate groups of experimenters among their engineering students and faculties. California experimenters cross the continent to report their work in New York before the Institute of Aeronautical Engineers.

Dr. Goddard's work thus may have opened a new era in transportation, for rockets can do more than explore the upper atmosphere. They ultimately may carry mail and goods—and possibly even passengers—with speed rivaling that of the telegraph; usher in an epoch of swift communication more spectacular than that brought by the telephone and airplane; alter once more the complexion of civilization as only basic inventions can alter it.

It was Col. Lindbergh who, in a letter recently to the President of Clark University, put the matter most directly:

"The rocket is now in that most interesting period of discovery where the shore lines are unplotted and the future limited only by imagination. We cannot state what speeds or ranges the rocket may attain, but it is not restricted by the rotation of an engine or by dependence on the atmosphere.

"As the airplane gave man freedom from the earth, the rocket offers him freedom from the air."

Soon to be Flooded

By JOHNS HARRINGTON

SAND-BLOWN and desolate ruins of the Lost City of Nevada will soon rub elbows with the fishes. The continued rise of the water behind Boulder Dam will shortly form a great lake which will cover the area of the ancient city completely. Since this was anticipated, the Southwest Museum in Los Angeles, California, through its curator, M. R. Harrington, has collaborated with the Federal Government in removing the relics from the prehistoric Indian homes, located about 65 miles from Las Vegas, near the small town of Overton, Nevada. The ruins of the settlement are scattered along a semi-desert valley for more than five miles, and now the approaching water has come within approximately two miles of the one-time city. Recognized as the largest discovered group of dwellings of its early period, the Lost City is 50 miles from the dam in a straight line. The inland sea, known as Lake Mead, has already extended, in another direction, from Black Canyon into the portals of Grand Canyon, a distance of 115 miles.

A portion of the Lost City, soon to be inundated by the waters of Lake Mead

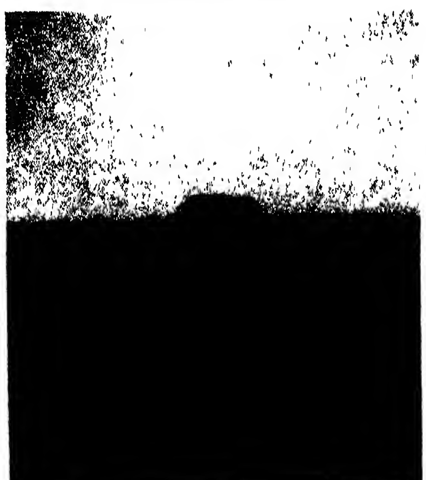
The aboriginal homes varied from one to 100 rooms in size, being constructed either of adobe and stone or adobe alone. The larger dwellings had semi-circular shapes, and consisted of a succession of single, connected rooms grouped around courts.

A MUSEUM has been erected above the water line of the oncoming lake, where most of the specimens from the more recent excavations are on display. A replica of one of the prehistoric Indian homes was built nearby; the remains of a habitation belonging to an even earlier period, which happened to be on the grounds, were restored.

Harrington, the director of the later excavations, has estimated that the Lost City was probably an active center of Indian habitation about 800 A.D.

The Indian methods of making arrowheads, basketry, and pottery, of weaving cotton cloth, and even of tilling crops of squash, corn, and beans, were revealed by archeologists. In growing crops, the aborigines first made brush dams in the small river of the valley to raise the level of the water so that it would flow into irrigation ditches. The dams were constructed by driving stakes into the river bottom, and piling brush and rocks on the upstream side, which stopped the water sufficiently for the purpose for which it was needed.

Generally, the pueblo Indians of the Lost City were short-statured and lightly-built, having the round skull type. Both men and women wore fiber sandals, and the women were usually garbed in cotton gowns which reached to their knees. The material was either white or dyed a purplish color; a woven belt of cotton, with decorations in red or black, was often worn. The men were dressed in a white cotton breech-clout or kilt, which was kept in place by a loose string belt. A head-band, with fringe on the lower edge, was also worn.



"The Temple," as viewed from Lake Mead, behind Boulder Dam

A baby was carried on his mother's back in a cradleboard, which eventually caused a slight deformation in the back of the infant's skull as a result of being strapped to the board for long periods at a time, this effect being permanent.

Judging both from archeological evidences and comparisons with modern Indians who are related to the Lost City residents, much of the distribution of labor in the ancient colony has been surmised, probably with fair accuracy. The men were responsible for the heavy work, such as hunting, most of the farming, and house-building; they also did the weaving and spinning. House work, the preparation of food, pottery and basket making, curing of skins, and gathering of seasonal natural crops such as the mesquite-bean, were the women's labor. They also were probably owners of the land and houses.

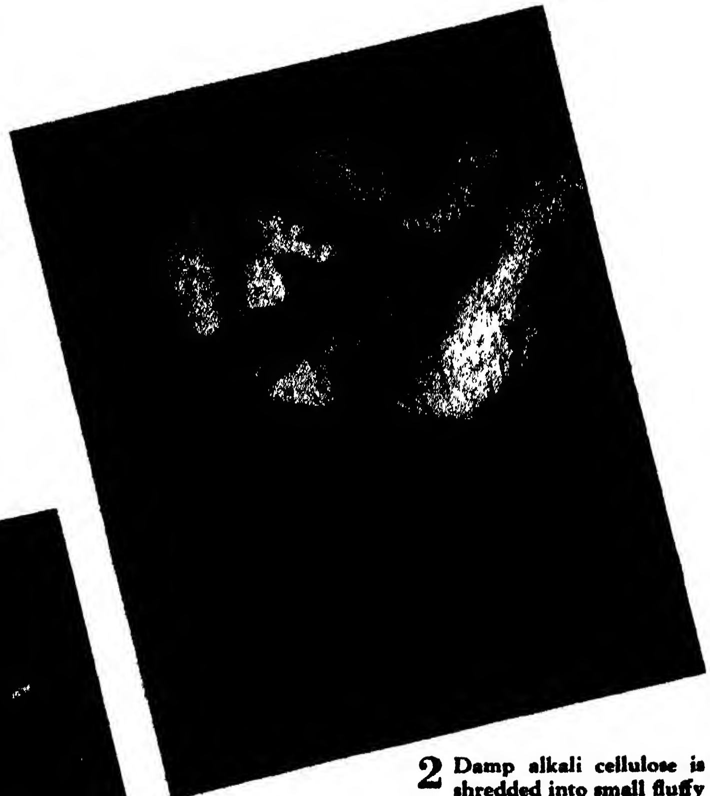
Several miles from the Lost City were some salt mines, which are now inundated. Here the aborigines mined the salt with crude stone hammers, lighting their work by torches often made of bundles of small sticks. The Indians probably traded their local product for elk-antlers from the mountains far to the west, and for shells from the Pacific, also hundreds of miles away.

More than a thousand years have passed since the Lost City was deserted; the walls of the prehistoric dwellings have crumbled to the ground, and will soon be covered by a great lake. Yet, through the efforts of archeologists, the culture of these people has been preserved for those who seek knowledge of peoples, civilizations, that have lived, and, during the unceasing tread of time, have fallen and been lost.

CELLOPHANE IS BORN

By A. P. PECK

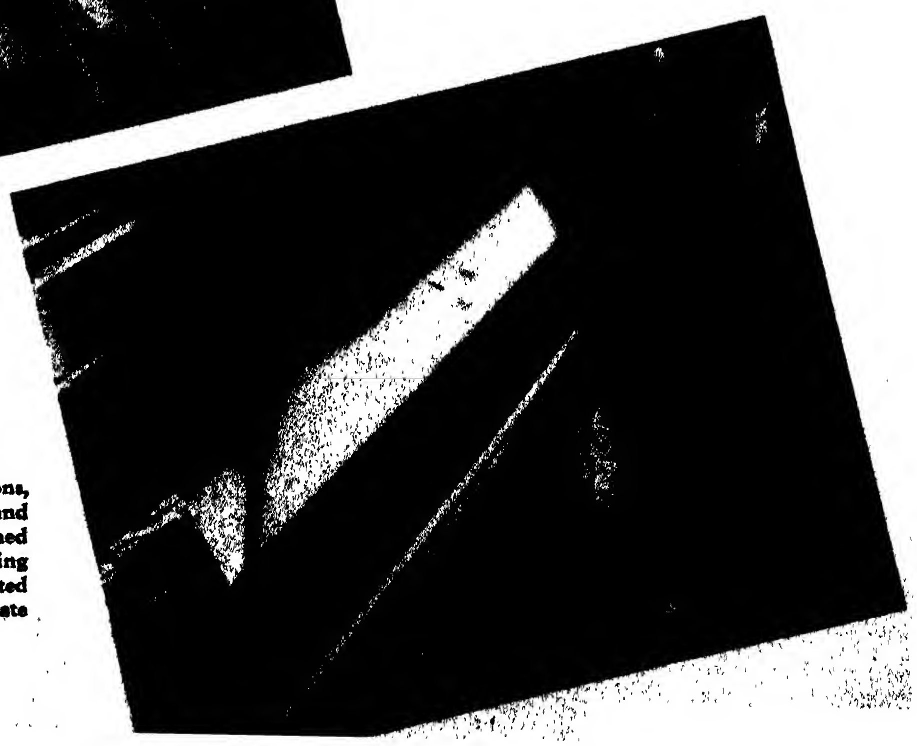
1 From forest giant to Cellophane is a long stride made possible by chemical research. For the manufacture of Cellophane, the Du Pont Company buys wood pulp—purified cellulose—in square sheets, soaks them in a caustic soda solution (above); the result is "alkali cellulose"

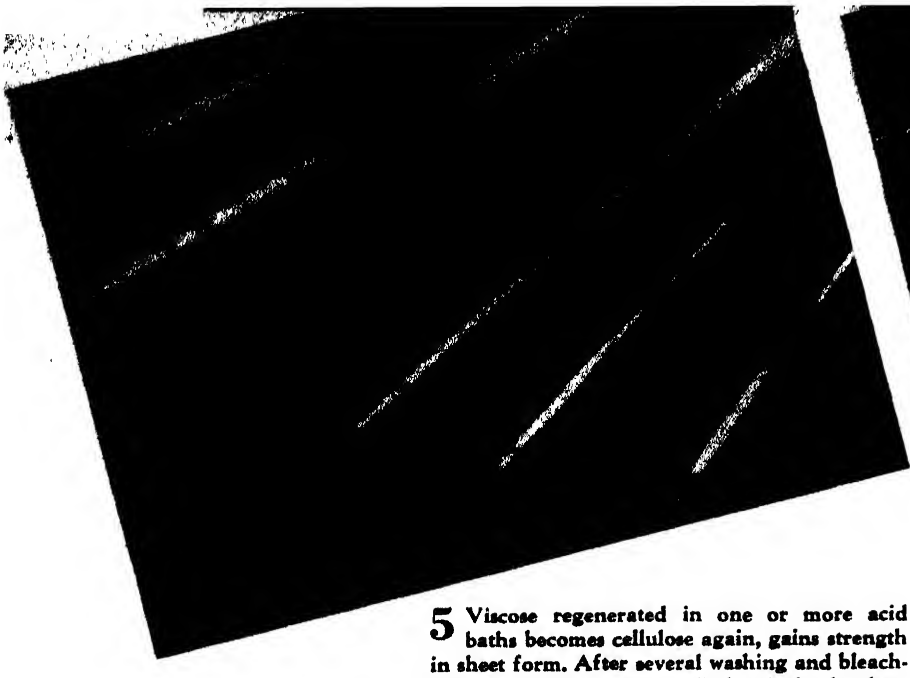


2 Damp alkali cellulose is shredded into small fluffy particles, aged for two to three days in order that later steps in production may be carried out successfully. *Above:* Unloading ground-up chemically treated cellulose from shredder

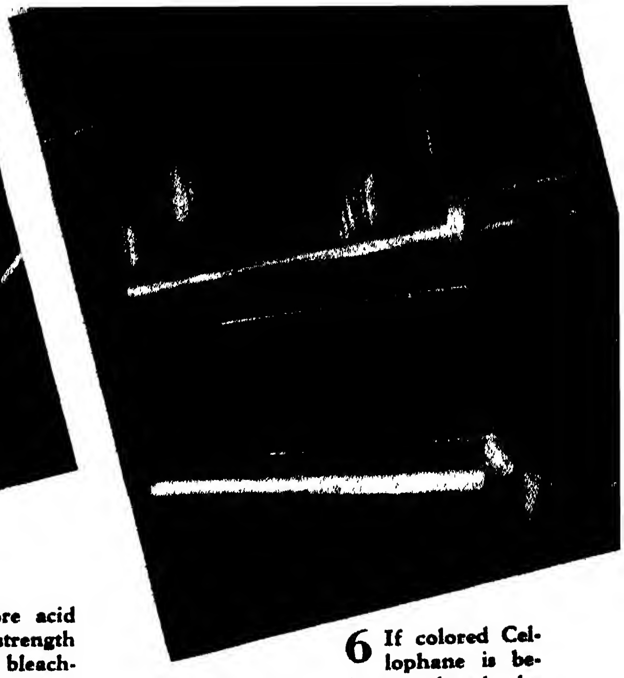
3 Aged alkali cellulose is treated with carbon disulfide, result of the reaction being cellulose xanthate. This compound, dissolved in caustic soda, becomes viscose, which in turn is aged or ripened in battery of tanks shown above

4 Viscose ripened under controlled conditions, checked to insure uniformity, is filtered and re-filtered to remove all solid particles. Ripened viscose emerges from a narrow slot in a casting machine as a thin, weak sheet (right), is treated with dilute sulfuric acid and sodium sulfate





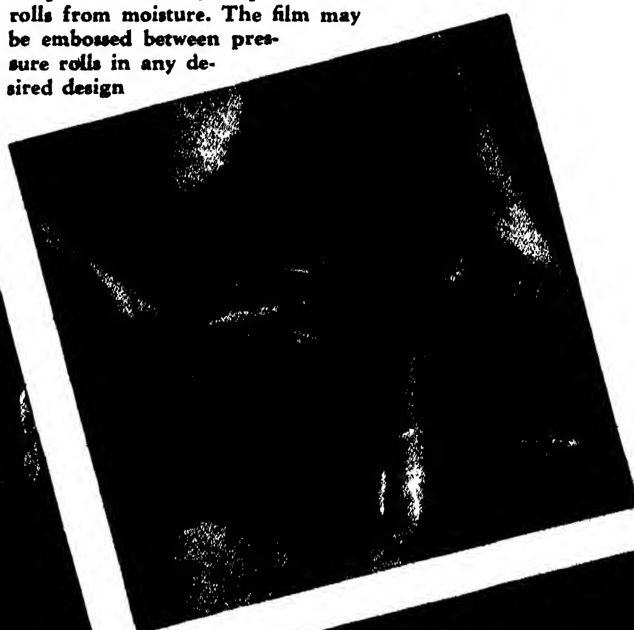
5 Viscose regenerated in one or more acid baths becomes cellulose again, gains strength in sheet form. After several washing and bleaching operations to remove all chemicals, the sheet passes through a glycerin and water bath and through heavy squeeze rolls (above). In the last bath the film absorbs enough glycerin to keep it pliable

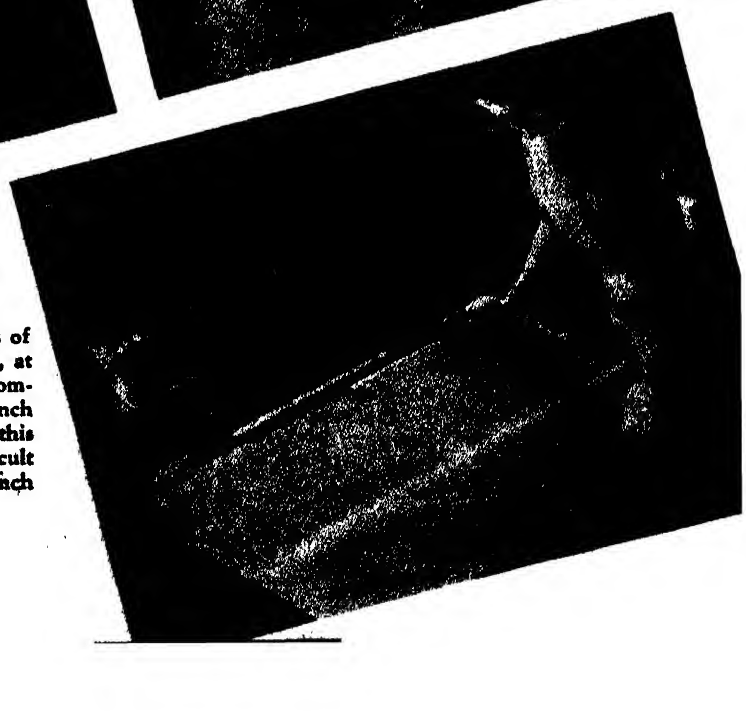


6 If colored Cellophane is being produced, the sheet is dyed before the glycerin bath. *Above:* The finished Cellophane film being wound on large cores. Winding was proceeding at full speed when photograph was taken. The next step is cutting the finished film to length

7 Rolls of Cellophane are run off onto huge drums (below) and then cut to length. Moisture-proof Cellophane is produced by passing a moist film through a moisture-proofing solution and drying. Both sides of the Cellophane are so treated simultaneously

8 Cellophane wrapped in Cellophane (below), to protect the rolls from moisture. The film may be embossed between pressure rolls in any desired design





9 Keen-eyed girls (right) are employed to assort and inspect sheets of Cellophane, cut from long strips made by the process described, at the Richmond, Virginia, plant of E. I. du Pont de Nemours and Company. Cellophane film is usually made about .0009 or .0013 of an inch thick, some being made .0018 of an inch thick. Thicker sheets than this are made by cementing several thin sheets together, since it is difficult in production to make a single sheet thicker than .0018 of an inch

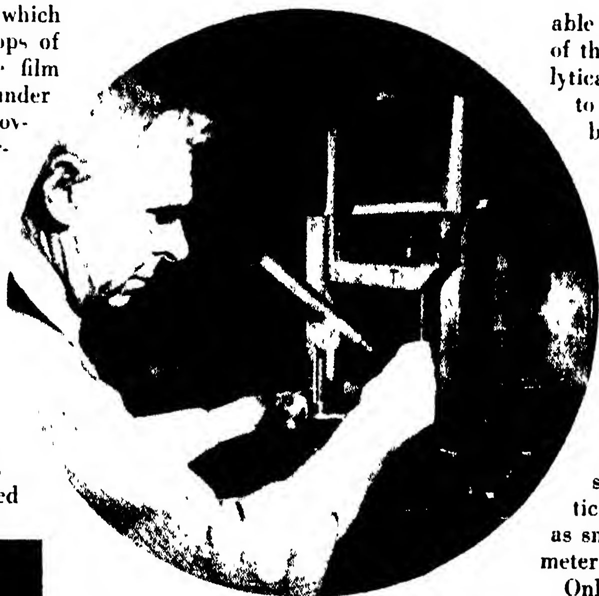
CHEMISTRY'S NEWEST SLEUTH

Micro-Analysis Enables Chemists to Study Minute Samples . . . Diagnoses Product Flaws and Ailments . . . Supplements Usual Laboratory Methods

By A. L. WHITE

IN one of the early experimental sulfur-dioxide refrigerators, a deposit formed and caused stalling. A minute sample of this film, procured by scratching a needle over the surface, showed a white salt when placed under a microscope. This white salt film was washed with petroleum ether, a solvent which removes undecomposed oil, after which it was wet with water. When drops of water and acid drawn from the film through a capillary were studied under a microscope, sulfo-salt was discovered. It was concluded that the original salt had been altered by exposure and that the cause of the trouble arose from the effect of moisture upon sulfur dioxide. By getting rid of all moisture from the materials and in the assembly, the deposits of film were obviated.

This process of discovering the cause of such deposits, of flaws and mishaps, by dealing chemically with very minute quantities of a chemical substance is termed micro-analysis. It is the most recent sleuth to join the forces of applied chemistry. It snoops into the hidden recesses of tiny particles too small to be seen by the human eye, and finds the culprit hidden away in places requiring high magnification for observation.



Tiny quantities in micro-chemical analysis require delicate balances

A micro-chemical device to measure electrical quality of an oil drop

The use of this method has helped to make possible the perfect operation of many of the present-day household machines and appliances. It has been used to discover flaws in refrigerators, in heating units, in telephone apparatus, and in vacuum tubes, for analyzing minute specimens in biology and medicine, and in solving engineering problems.

It is a law of Nature that, no sooner has an engineer's creation been completed than deterioration or decay begins to set in. At the beginning this may be caused by foreign substances that are almost always microscopic and usually manifest themselves by abnormal deposits, corrosion, or operation. However, a few specks of dust from the windings of a motor, a bit of "gum" from a bearing, a small smudge from an electric contact point, or a tiny scraping of the faint discoloration on the bulb of a vacuum tube may serve as sufficient material for analysis by micro-chemical methods, and the analysis will be as conclusive as it would be if an unlimited amount of the specimen were available.

In the past, chemists have been faced with many difficulties in attempting to work with materials when only small particles were obtainable as samples. In such cases, the size of the apparatus used in the usual analytical chemistry was out of proportion to the quantities of the chemicals to be analyzed. Many errors resulted. But a chemical reaction obeys the same laws in the volume of a pinhead which it does in that of a tank. Therefore it is entirely feasible to perform chemical tests and manipulations on a reduced scale and observe the results under a microscope with appropriate magnification and illumination. By means of micro-chemical analysis, work can be effectively done even when the sample obtainable without practically destroying the object may be as small as five-thousandths of a millimeter in size.

Only about that amount of a specimen was obtained from sheets of iron-cobalt alloy which, when rolled very thin, changed in magnetic properties. With a pure silica abrasive a very tiny specimen was taken from the surface of the sheets, extracted from the abrasive and examined micro-chemically. This examination showed that the sheets lost iron through oxidation and subsequent mechanical removal; hence the change in its magnetism.

For this work, specialized apparatus, often of greatly reduced size, takes the place of the relatively large beakers,

Miniature bottles, beakers, and other equipment are necessary in micro-analysis method

flasks, test tubes, and the like, developed centuries ago. These are augmented by instruments such as the microscope, centrifuge, and micro-balance.

Often in making tests to determine the quality of some substance, the microscope and the capillary are sufficient. Such was the case when tiny discolorations appeared on the surface of a polished silver sheet used in the manufacture of photo-electric cells. A very small drop of nitric acid was allowed to act for a few seconds on the discolored spot. When part of this was redissolved in a small drop of water and drawn up into a capillary tube, heated, then examined under the microscope, minute droplets of mercury were discovered.

IN telephone apparatus, contact points of various metals and alloys are extensively used. In case defects occur in contact points, obviously only the very smallest particle of the metal can be taken as a sample in order not to impair the operation of the contact point. Consequently, micro-analysis must be used. Usually, a drop of acid is deposited on the contact by means of a micro-pipette, then drawn back into the pipette by capillary action as a slurry, or mud. The slurry of loose smudge in the barrel of the pipette is drawn out into a tiny tube with a conical bottom into which the solid particles are driven by centrifuging, a clear acid being then withdrawn from the pipette. Now the smudge is ready for the analysis.

A similar method was followed in determining the nature of a deposit on the shaft of an experimental electric meter which had caused stalling. A small drop of oil was first applied, and the deposit was gently rubbed with a special glass tool to loosen it. The oil slurry which was formed was taken up in a capillary pipette and separated by centrifuging for its analysis with chemical reagents.

Many instances occur where micro-analysis is the means of determining faults. Recently some chromium alloy heating units scaled seriously when at a red heat. Chromium alloys are subject to attack by alkalis when heated in the presence of air; upon examination of the heating units, traces of sodium were found in the surface material. Microscopic examination of the surfaces of the plates from which the units were fabricated showed the plates to be covered with a pasty film. Micro-chemical tests showed that this film was a soda soap. Upon inquiry, it was learned that a grease, which is a soap-oil compound, had been used as a lubricant during manufacture and that the solvent used to rinse off the grease dissolved the oil but did not remove the soap. When heated, soap is converted into ordinary soda, a powerful alkali; hence the scaling of the heater elements.

Micro-analysis has found a large variety of uses. It is used for diagnosing corrosion causes; for the identification of surface contaminants such as tarnish films; for composition studies on thin layers or small areas to determine the constituents; for the analysis of dust; for determining the causes of transformation and deterioration in materials; and for the identification of foreign substances in any material.

While it works with smaller quantities than are used in regular analytical laboratory work, and many of the processes are the same, it must not be considered a mere reduction in scale of methods and standard laboratory procedure. Nor does micro-chemical analysis supersede the standard laboratory practice; it supplements it by providing a means of analyzing specimens which cannot be handled by standard procedure. As the application of micro-analysis to engineering problems increases, we can look for greatly improved products and materials in the future.

■

The first step, above, in determining the cause of a defective electrical contact. A smudge is "lifted" by a drop of acid first deposited and then removed by the micro-pipette. At the right is shown the slurry, or loose smudge, in the barrel of the pipette. From this, it will be blown into a tube and centrifuged. The clear acid is then drawn off and the deposit analyzed

This deposit on the shaft of an experimental electric meter has caused stalling. It will be taken off by using oil and a tiny pipette and then analyzed

INSULIN FOR SCHIZOPHRENIA

An Estimate of the New Insulin Shock Treatment for Schizophrenic Insanity . . . The Enthusiasm for this Astounding New Method Apparently is Justified

By BARCLAY MOON NEWMAN

THERE is a new and strikingly valuable treatment for insanity. No longer ago than 1930, Dr. Manfred Sakel, psychiatrist of Vienna, Austria, was interesting himself in the problem of morphine addicts just taken off their drug. As had many before him, he noted the symptoms of high excitement, frenzy, mania, and even real though brief insanity which immediately follow when an addict is denied his morphine. But Sakel pondered the problem more deeply and to far better purpose than had any other psychiatrist. He developed a theory.

Keenly observing the shifting mental states of addict after addict under treatment as dope fiends, Sakel concluded that some physical or bodily change is suffered by the addict, as well as a mental change. He believed that the cells of the brain, under the influence of the morphine—of course a poison—undergo actual injury, and in this injured condition attract to themselves more than usual quantities of exciting substances from the body's glands.

Now, the depressing action of insulin, because of the extensive use of this substance in treating diabetics, was common knowledge. Insulin is normally produced by the healthy pancreas, and aids the body in its use of sugar. In a diabetic, insulin is lacking, and if injections of this substance are not given, hundreds of thousands of diabetics, all over the world, would die early deaths—often with far too much sugar in their blood. But inject the appropriate number of units of insulin, and the quantity of sugar in the blood remains at the normal level. On the other hand, administer an overdose of insulin, and the diabetic's blood sugar drops to a dangerous degree. The diabetic acts as though intoxicated by alcohol, and may even sink into a coma, if the dose has been strong enough, and if sugar is not administered. Hence overdosage followed by drowsiness is not rare. And insulin is not a narcotic in the strict sense of the term. Sakel decided that insulin may safely be used to pacify the excited nerve cells of morphine addicts. His success was astonishing and exceedingly suggestive.

Though only small doses of insulin were used in treating the morphine addicts, striking mental changes were observed. Violent patients became calm. Those immersed so deep within their own sad inner world as to appear lost, were brought back to reality. Unfriendliness gave way to friendliness, and angry antagonism to cheerful co-operation. Such alterations in behavior were frequent even during the first days after denying addicts their morphine. And the first days are the worst.

In the physician's mind, a great hope and a great discovery were dawning. Insulin apparently caused the excited patient to relax, to be normal, often for lengthy periods, sometimes permanently, though only small doses were administered. What will insulin, perhaps in larger doses, do to the insane brain? This was Sakel's daring thought.

OUR Columbus of the world of the mind proceeded slowly, cautiously, painstakingly. Of course, from experience with diabetics and morphine addicts, he had already learned that comparatively large doses of insulin are not harmful, except in rare instances, and then prompt feeding or injection of glucose removes all ill effects. But naturally he wanted to be doubly sure. He was a most conscientious physician.

Dr. Sakel had not devoted his life to his patients in vain. Each step, thought out carefully and carried out with utmost regard for his patient's safety, marked a success. Hence this pioneer early learned the main restriction to his work among the insane: all types of psychoses do not respond equally well. Schizophrenics as a group are highly benefited, manic-depressives are not.

Schizophrenics ("split personalities") include those whose minds are weirdly wandering inward, lost within themselves. They elaborate a vast dream world all their own, and live and continually converse with non-existent kings, queens, Indian princesses, as well as other royalty. Generally, a schizophrenic believes himself to be another person. This creation represents an escape from reality. Such psychoses constitute the greatest group of our insane—and are described as driven out of their minds by "functional" causes. "Functional," however, means practically nothing—beyond the fact that the cause of schizophrenia is not known, and cannot be traced to a physical defect.

There is another great class of functional psychoses: the manic-depressives. These patients alternately exhibit excessive excitement and excessive depression of spirits. In this case too, the term "functional psychosis" indicates entire lack of knowledge as to underlying causes. And, as a matter of fact, no one is sure whether the schizophrenic's bizarre dreams and the manic-depressive's fluctuating emotions are diseases in themselves or merely symptoms of some hidden bodily affliction, having a secondary rather than a primary connection with the brain.

Therefore it is all the more remarkable that Sakel has found a treatment for a disease whose creeping cause is entirely a mystery, and for that disease which possibly accounts for the greatest percentage of the 100,000 annually admitted as new cases to institutions for the insane in this country.

Dr. Sakel determined that the best results are achieved when increasing doses of insulin are given, until the so-called shock dose is reached. This maximum dose varies according to the individual, and ranges anywhere from a mere 15 units of insulin to 450 units.

By shock dose, Dr. Sakel means the quantity of insulin needed to produce deep coma in any individual within four to five hours after injection. After the shock dose has been reached, this dosage is given three to six times a week until the patient has received the greatest possible benefit. Provided that the patient does not respond—not all patients do—no more than 50 injections are given. In case a patient reacts unfavorably to a shock dose, by sinking into too deep a coma, or by developing too rapid or too slow a pulse, he must be allowed to rest for two or three days. In all instances, at least one rest day per week is allowed.

Dr. Sakel's greatest difficulty has been in finding out how long to leave a patient in the coma and how many shocks to give. Some individuals need no more than eight shocks. Others do not respond

until about 50 shocks have been given. The treatment is ended by a tapering-off process—a smaller quantity of insulin is given each day until the first low dosage is reached.

The patient is not allowed to eat before the injection. Typically, the insulin is given about 6 A.M., before breakfast. At about 10 A.M., the action of the insulin is terminated by administering a solution of sugar in water, by mouth or vein. During this four-hour period, if a shock dose and coma are in order, the patient is kept in bed and carefully observed for any untoward effects. Bath and breakfast follow the sugar. The patient may spend the remainder of the day up and around. But close watching is essential, because the blood sugar sometimes stages a second and unexpected sharp drop, even after three full meals. Then more sugar must be given.

And so, in 1933, Sakel reported the cure of his first patient, and afterward many patients, and published conservative reports of his success. These reports upset the psychiatric world, which found them at first incredible, despite Dr. Sakel's already high reputation. Specialists came to see for themselves: first from Austria, then from every nation. The most eminent among them were impressed, and stayed to be astonished. Sakel's methods spread everywhere, and everywhere a high percentage of apparent recoveries has confirmed, and more than confirmed, his own results. In 1936, Sakel's technique was introduced into this country, and Sakel himself came to America. Now every large mental hospital in the United States is experimenting with this treatment.

WE can imagine the eagerness with which medicine has taken up Sakel's method, and with which it observes the response of more and more patients. Even the small doses at the start of the treatment often cause remarkable improvement. Tension is diminished. The patient is far calmer. As the shock dose is approached, the changes in mental powers and in attitude are dramatic. To the most confused and excited people, with minds seemingly utterly gone, periods of sanity return. Frequently the most unpromising patients, with a long history of insanity behind them, suddenly lose their vivid hallucinations and snap back to full mental clarity and enduring mental health. Among specialists throughout civilization, Sakel's own marveling thoughts are echoed:

"These changes are so dramatic that it is difficult to do justice to them in words."

Early in the treatment, the patient usually becomes aware—during brief, lucid moments—that he has been indulging in abnormal thinking and behavior. For a little while at least, a new style of thinking replaces the former stream of muddled ideas. The further the treatment progresses, the longer does the normal personality stay with the patient. But, almost invariably, in the early stages of the treatment, as blood sugar rises back to normal, the insanity creeps back again. Then, in patients who react favorably, the periods of mental clarity begin to endure even after the sugar in the blood has risen to its normal concentration. And in the majority of instances, termination of the treatment means that the gloom of insanity has been dispelled—frequently forever, it is believed.

One patient had a long and evil record. At 32, he had been a schizophrenic for six years—a chronic case. Disorderly conduct, burglary, imprisonment were part of his story. Thirty-one injections, including 18 shock doses of insulin altered him from a discontented, sexually perverted, dangerous criminal to a contented, normal laborer in a cannery. At last reports, he was putting in 12 hours a day on his job.

If other chronic cases of schizophrenia reacted as well, then a huge load would be removed from taxpayers' shoulders. Mental hospitals are full to overflowing with chronic cases. But this schizophrenic criminal is one of the few chronic cases which do show improvement and which do not relapse after insulin shocks. For insulin treatment is efficacious chiefly in early stages. Often a chronic schizophrenic will show temporary restoration to the normal condition—and then fade back into his world of delusion, inexplicably. Even doses of more than 200 units of insulin, and rather severe shocks or deep comas, do not permanently affect a dismayingly large percentage of those ill for a long time.

No one can deny, however, that Sakel has given to medicine a most astounding method. Into the saddest, gloomiest realm of all affliction he has brought brilliant light. What is more, he has provided the most hopeful of knowledge—that man can indeed learn to cure his millions of insane.

What happens to the patient's brain as insulin reduces the quantity of sugar in his blood? What takes place during the coma? How does the insane mind, made unconscious, turn into a sane mind when consciousness comes back? These are the chief mysteries which Sakel and all others engaged in this work of reconstructing shattered brains would like to solve.

One girl was questioned concerning her experiences during the insulin therapy. She replied that, after an injection, a sense of fatigue came over her. Next she felt very hungry. Gradually, awareness left her, and finally she sank into a blank unconsciousness, which she describes as a state entirely without sensation, without dreams: "I was merely asleep, but nothing more."

She had no idea how long she was unconscious at any time. Other patients say that as they lose awareness, they have a feeling of increasing intoxication or perhaps "poisoning," ending in complete oblivion. All agree that there are no dreams or sensations of any kind during their coma.

NO more is known concerning what happens during the rare spontaneous recoveries of untreated patients. The few schizophrenics that of their own accord snap out of their dreams, as it were, have no explanation nor any hint of what kind of healing goes on in their brains. Nevertheless, recovery due to insulin treatment has a definite advantage over any of these (infrequent) spontaneous recoveries. Patients who get well without treatment are evasive about their hallucinations and their illness as a whole (though insanity is no more to be ashamed of than measles). That is, they do not fully understand what has occurred nor entirely realize that they have been mentally ill. They tend to blame external circumstances for what has happened to them, thus often complaining that some mysterious event such as a blow on the head brought on the mental difficulties.

A healthier condition exists among those cured by insulin. They recognize that something serious has been wrong, and freely admit: "I guess I was just crazy for a while, Doc, but I'm O.K. now."

This is a far more normal attitude. One who admits the truth does not have the odd brain twist evident in those who distort or falsify. And mental cases treated by insulin get well much more rapidly than any who recover without any treatment. Even in the fairly rare instances where it does occur, spontaneous recovery is always slow, uncertain, and expensive.

What is the danger in shocking the mentally ill back to health? Many physicians report no ill effects of any kind. Without careful control and experience the method may, however, result fatally.

What is the extent to which patients retain their recovered mental health? Sakel's first patient is still altogether normal mentally after five years. Many other patients appear likely to stay well. Yet, Sakel is the first to point out that not all recoveries are permanent. A small percentage relapse.

All in all, Sakel's insulin technique may be considered a great stride toward treating our major classes of insanity by physical methods. As Sakel puts it: "Psychiatrists need no longer have that paralyzing sense of insufficiency toward their psychotic patients that they used to have."

He has brought more: confidence that someday, perhaps soon, as suddenly as his discovery appeared, there will come cures for other types of insanity.

Starch from the Sweet Potato

A general view of the sweet-potato starch factory at Laurel, Mississippi, possibly the forerunner of many similar plants in southern sweet-potato-growing regions

In Laurel, Mississippi, in the heart of one of the South's principal sweet-potato-growing sections, there is being manufactured a product that bids fair from present indications to form the basis of a flourishing new southern industry—the production of sweet-potato starch. Long existing only in the minds of chemists, sweet-potato starch of a purity, color, and quality equal to that of the finest starches is now an actuality, and hundreds of thousands of pounds are being produced commercially at the Mississippi plant.

The full capacity of the new starch factory is 200,000 bushels of sweet potatoes per 100-day season, yielding, on an average, approximately two million pounds of starch. During the manufacturing season, the plant operates on a 24-hour basis, including Sundays. It is estimated that no fewer than 150 plants as large as the one now in operation will be necessary to fill this country's demand for root starch.

Cull potatoes are, at present, the main source of sweet-potato starch, although there is an increasing tendency on the part of farmers to deliver field-run potatoes, grown especially for starch-making.

In the manufacture of starch, the sweet potatoes, delivered by farmers, are weighed and placed in large bins, from which they are fed into a flume leading to the washers. Here power sprayers remove every vestige of grit and foreign matter. The potatoes are then ground to break up the starch granules; during the grinding process chemicals are added for bleaching purposes. Following this, the mixture is screened to separate the starch-bearing liquid from the pulp. From the screens this liquid is drained off into mixing machines for another step in the bleaching process. The pulp is dried and sold as stock feed, a by-product of the factory. From the vats where the second and last step in the bleaching process takes place, the starch water is routed to troughs or tables, where the particles of starch settle to the bottom and the surplus water is drawn off. The starch is then transported to the dryers where all but an infinitesimal part of the remaining moisture is removed.

The success of the plant at Laurel has been brought about through the development of a successful process for removing the undesirable, yellowish color which has always prevented sweet-potato starch from being more widely used. During the grinding process, at which time the cell membranes enclosing the starch granules of the sweet potato are ruptured and the starch set free, a continuous stream of water carrying sulfur dioxide in a concentration of 0.15 percent is fed to the pulp. If no further treatment were given, the finished product would have the desirable degree of whiteness, but further treatment is needed to insure stability of color.

This additional treatment consists of draining off the water containing the starch and sulfur dioxide from the pulp and concentrating the former in mixers. Sodium hydroxide is added, and the mass stirred constantly for three to five hours. At the expiration of this operation, the starchy liquid is fed on to the settling tables. The finished product is a starch of the desired degree of whiteness and will retain its color indefinitely under practically all conditions.

Sweet-potato starch was not placed on the market until it had been conclusively

A typical southern field of sweet potatoes. Either culls or field-run roots, grown especially for starch-making, may be delivered to the starch factory by the farmer

demonstrated that it was fully as good as other root starches, and far superior to some. In the textile industry, for instance, where tremendous quantities of starch are used for warp-sizing and finishing cotton goods, mill operators say that where this new starch is used results have shown less loom stoppage, less shedding, and better-feeling cloth. As all of this contributes substantially to the finished product and lessens production costs, this industry at present consumes almost the entire output of the Mississippi plant.

In tests conducted jointly by the Bureau of Chemistry and Soils and the Bureau of Engraving and Printing, it was found that sweet-potato starch is the only starch produced in the United States meeting the requirements for an adhesive for postage stamps, labels, and envelopes. This is because sweet-potato starch makes possible the high degree of viscosity demanded by the Bureau of Engraving and Printing in its adhesives, and because it has a high degree of purity and an inoffensive taste. At present, foreign-produced and imported cassava root starch is used exclusively by the Federal Government for this purpose.

Purity, Color, and Quality Equal to the Finest Starches...Bleaching Process Perfected...Of Great Economic Significance . . . Now in Production

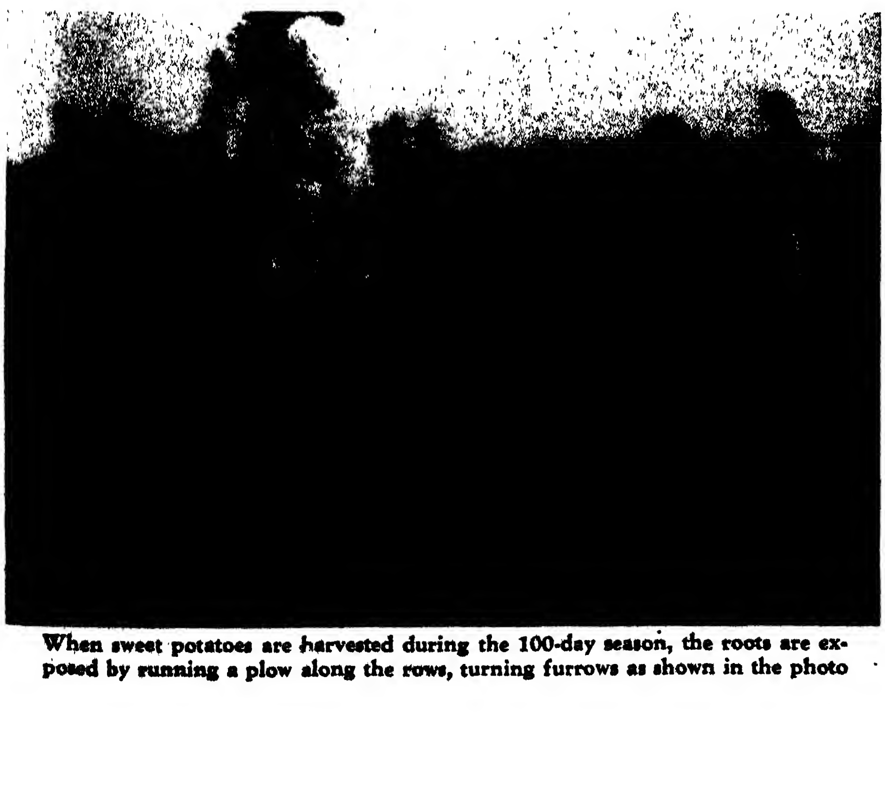
By FRANK A. MONTGOMERY

In the research laboratory of the Mississippi starch factory. Note particularly the size of the sweet-potato root that is held in the hands of the worker at the right

THE United States consumes more than one billion pounds of starch a year, most of which is manufactured in this country from cereals such as corn, wheat, and rice. Large quantities, however, are also made from white potatoes, which furnished industry in the United States with its only native root starch until the advent of the sweet-potato starch factory in Mississippi. It is not unusual that so much starch is used in this country when one considers that the following products use starch in greater or lesser quantities: Adhesives, food products, textiles, paper, soap, explosives, veneers, toys, salt, yeast, baking powder, cosmetics, alcohol, and batteries.

Although, as has been pointed out, the United States does produce most of the starch needed by industry, such starch is cereal starch and is unfit for certain uses. These other uses require a root starch, making it necessary for this country annually to import some three hundred million pounds of such starch. Most of this foreign-produced starch is made from the cassava root; it has been ascertained that starch from the sweet potato can replace this starch in every department.

Consequently, because sweet-potato starch as produced in this country is a high-quality root starch, because the raw product from which it is obtained can be produced cheaply in this country, and because such starch can be used satisfactorily for every purpose for which the imported root starch is used, it is felt by authorities that the plant in Mississippi will undoubtedly be the forerunner of many such plants in the southern sweet-potato-growing regions.



When sweet potatoes are harvested during the 100-day season, the roots are exposed by running a plow along the rows, turning furrows as shown in the photo

IF such an event does come to pass—and it seems logical to suppose that it will in view of the success already attained by this new industry—this nation will be relieved for all time of its dependence upon foreign nations for the root starch it consumes.

The Laurel plant was financed and sponsored by the Federal Government with the objectives of developing an industry that would alleviate the rural-relief situation in southern Mississippi, and that would, at the same time, be of permanent benefit to southern agriculture. A second plant, privately financed, is being planned in Florida.

A Great Work Completed

The Monumental New General Catalog of Stars for the Professional Astronomer, in Preparation More than 30 Years, is Finished . . . An Enormous Task

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington.

FIVE substantial volumes, arriving at observatories the world over, have been welcomed with unusual interest, for they contain the great General Catalogue of the positions and motions of the stars which has been in preparation for more than 30 years.

At the beginning of the present century, a vast amount of observations of the positions of the stars had been collected by the independent activities of astronomers in many places. These formed an important part of the accumulated capital of astronomical knowledge—assets which must have represented an actual financial outlay of hundreds of thousands of dollars—mainly in salaries. The late Professor E. C. Pickering told the writer, years ago, that he had found that the salaries paid the observers and computers who worked on the preparation of the two Harvard Zone Catalogues, of a few thousand stars each, had in each case added up to much more than the original cost of the instrument with which the observations were made—and a meridian circle is not a cheap kind of telescope.

BUT, 30 years ago, this vast and valuable accumulation, in an audit of the existing state of the science, would in large part have been listed as "frozen assets"—to use a modern phrase. The extant catalogues gave the positions (right ascensions and declinations) of great numbers of stars. But it is of little interest to know merely the fact that a star is in a given place in the sky. Sometimes, indeed, this is what the astronomer wants. He may have observed a comet, in the usual fashion, by comparing it with a near-by star, and measuring the differences of right-ascension and declination. Then he wants badly to know where the star was when he observed it. By looking in one or another of the long shelf of star-catalogues which are an essential part of every observatory library, he may find his star and a good observation of its position—very likely in 1885 or thereabouts. But this does not give him what he wants, for the stars are moving in the heavens, and there is a considerable chance that the motion in 50 years or so, if not allowed for, will throw his results out by considerably more than the error of his own measures. Hence even the simon-pure positional astronomer—who uses the stars only as reference points for his measurements, without worrying at all about their distance, brightness, or physical nature—requires catalogues of reference which give not only the position of the star at a given date, but also its proper motion per year or per century, so that he may find where it was when he observed it. But the utilization of star-positions as points of reference, though essential for certain types of work, represents only a small part of the whole value of the data. The proper-motions of the stars, indeed, are much more valuable than the positions—for it is from a study of these that moving clusters have been detected, that the sun's motion among the general field of stars has been revealed, and that good average values have been found for the parallaxes and distances of stars of almost every kind—many of them much too far off for direct measurement.

The astronomical assets of 1900 could fairly be described as frozen, for a reason only too familiar in these days—it cost too much to realize on them. If an individual worker greatly desired to know the proper-motion of a particular star, he could look it up in all the star-catalogues in his library—he might find it in half-a-dozen or more. Some of these would give the position for 1875—that is, referred to the equator and equinox of that date as standards, others for 1900, others perhaps for a different date.

To allow for the motions of equinox and equator in the interval, and reduce them all to a common standard, is simple enough in principle but time-consuming in practice—even though the catalogues give data which greatly shorten the calculations. After this had been done, our student would have a set of positions at different times of observation, all referred to the same standard. By plotting the right ascensions or the declinations against the time, he could see whether the star was moving and how fast. But, even then, his troubles were not all over. The observations, like all other human products, are not perfect; they are affected by errors, which will reveal themselves by throwing the plotted points off the straight line representing uniform motion. Some catalogues will be more accurate than others, and the allowable tolerance—as an engineer would say—for deviations of the points representing them should be smaller.

It is easy enough to take this into account, if one knows which observations are better, and how much. But we have no *a priori* way of finding out how accurate anybody's observations are; this can be determined only from the degree of their agreement with one another and with other people's observations. Hence the lone student, trying to work up the particular star, would be at a loss, and his results, though they would reveal any conspicuous motion, would not attain the full accuracy that was obtainable from a complete discussion of the material.

IN 1900, of course, the isolated worker would often have been spared this labor. Comprehensive catalogues of large numbers of stars—especially the brighter ones, and those of large proper motion—had been published and were at his service. But even these had not all been prepared on exactly the same system. The allowances for precession (the motion of the equinox) might, for example, be slightly different in different catalogues.

More than 35 years ago, Professor Lewis Boss—director of the Dudley Observatory at Albany, and a recognized expert in this field—was so much impressed with the importance of constructing a general catalogue of star-positions and motions, that he convinced the Trustees of the Carnegie Institution of the great scientific value of the plan. After preliminary trials, the Institution established a Department of Meridian Astrometry to undertake the work.

The task was enormous. The tens—nay, hundreds—of thousands of observations made since 1755 (when Bradley did the first work which meets modern tests of accuracy) had to be collected, and reduced to a uniform system. Moreover, all the stars were re-observed, with

every care for the utmost accuracy, so that a longer time-interval should be available for the determination of their motions. In this part of the program the Albany meridian circle was most carefully dismounted, packed, and set up at San Luis in Argentina, where 87,000 observations of southern stars were obtained. It was then returned to Albany, where 110,000 observations of northern stars were secured.

Finally all this vast mass of material had to be assembled, card-catalogued, discussed with great care to remove all recognizable sources of error, and at last assembled into the Catalogue. The computations were numerous, and, to avoid error, every one of them was done twice independently. It is no wonder that all of this has taken a long time.

A "PRELIMINARY General Catalogue" containing 6188 of the brighter stars (and hence practically all that are visible to the naked eye) was published in 1910, and has been the stand-by of astronomers everywhere ever since. The final General Catalogue contains 33,342 stars, including all brighter than the seventh magnitude, and many fainter ones for which good observations were available.

Professor Lewis Boss lived to see the Preliminary General Catalogue welcomed by the astronomical world. In 1912 he died. His son, Dr. Benjamin Boss, with several collaborators, has spent a quarter of a century in bringing his father's plans to complete fruition. In preparing this great catalogue no less than 238 individual catalogues were utilized—each based on original and independent observations. The earliest observations date from 1755. The last which could be incorporated into the work go down to 1925 (and were published some years later). Every one of these catalogues was the object of detailed and painstaking study —for the hardest part of all the work has not yet been mentioned.

Observations with any particular instrument—even the best—are subject to small "systematic" errors which do not "average out" in the mean of a large number of measures, as ordinary casual errors do. A good example is the magnitude equation in observations of right ascension. When an observer notes the time of transit of a star across fixed wires in his telescopic field of view, he is more likely than not to record the passage of a bright star earlier than that of a faint one. For some of the older observers, the extreme difference was as great as a tenth of a second of time. Usually it is less; but it shows up definitely in the average. To find the amount of this error, close-woven wire screens were placed in front of the telescope, acting simply as obstructions to the light, so that only one percent or less passed through. A bright star could thus be made to look, to the observer's eye, just like a faint one, and, by comparing numerous observations made with and without screens of different transmission, the amount of the error for different stellar magnitudes could be determined. The modern method of following the star by a moving wire, which automatically sends electric signals when it reaches definite positions in the field, much diminishes this error.

If in the preparation of a given catalogue observations with screens have been made to determine this correction, the compilers of the General Catalogue have none the less to go carefully over their published accounts of what they did, checking up on every point. If no such observations were made, the compiler still has a chance. He may compare the results of this catalogue with the average from other catalogues in which correction for magnitude error was made, and so find how much, on the average, faint stars were observed late compared with the corrected observations. With a large enough number of stars, this process gives reliable values of the corrections necessary to reduce the results of the particular observer to the general average of all.

Many other sources of error present in the observations of a century ago have been reduced by modern refinements. For example, the clock upon which the transit observations depend, might not be perfectly compensated for temperature, and might run slower by night than by day. Modern clocks, in constant-temperature vaults, are free from this danger; but minute differences of the same sort between the results of different observers are present, and must be found and allowed for.

ONE of the most curious of these affects the declinations. The main part of the determination of these depends upon the graduated circles which are attached to the telescope, and read by four microscopes. The maker of the instrument has graduated this circle with the utmost practicable accuracy; but the small outstanding "division errors" have to be determined by the astronomer who uses the instrument—which is simple in principle, but takes a lot of work in practice.

After the telescope has been set so that the star, as it transits the field, passes near the center, the exact distance by which it goes north or south of it is measured by setting a micrometer-thread on the star. When a meridian-circle telescope is pointed almost straight upward, its eye-end is lower than a man sitting in a chair could reach, so that it has always been customary for the observer to be on a sort of couch, adjustable so that he can get his head under the eyepiece and look up without getting into a strained position. When observing a star south of the zenith, his head is north of the piers on which the axis of the telescope is carried, and his feet extend to the southward; for northern stars, his head is south and his feet north.

Now, in a great many cases, comparison with the general run of observations shows a discontinuity in the declinations measured at a given observatory, just at its zenith. The explanation is not far off. In setting a micrometer wire—which, as he looks, runs parallel to the line joining his eyes—upon a star-image, an observer may tend to place it slightly "above" the star, as he sees it, or perhaps below. When the observer changes ends in passing from northern to southern stars, what is "below" to him (toward his feet) alters its direction with respect to the telescope, and to the stars.

This is but one of many possibilities which the compiler of a general catalogue must have in mind. Only an astronomer thoroughly familiar both with the actual methods of observation, and with all the refinements of the theory of errors, should attempt so delicate a task: and years of experience are required before his judgment upon the relative weights which should be applied to the results of different catalogues is fully mature.

Almost half of the 339 pages of the first volume of the General Catalogue are occupied with tables of the various systematic corrections which have been applied to reduce the results of each catalogue to the adopted standard system. Another hundred pages deal with stars close to the poles, where the right ascensions change so rapidly that it is necessary to tabulate them at intervals of ten years, or even for five, as for the Pole-star. The remaining four volumes, averaging 330 pages each, contain the main body of the Catalogue. Beside the positions (for 1950) and the all-important proper-motions, it gives the magnitude of each star, and its spectral class. More than 6700 stars were specially observed photometrically at San Luis, to make the list of magnitudes more accurate, and those spectra, which had not already been observed at Harvard were specially looked up there.

THE completed volumes represent a transformation of the great mass of frozen assets into liquid and available form. A wealth of information about the distances and motions of stars of all sorts is contained in the proper motion —only waiting to be worked up in detail. In this phase of astronomy, we can be quite sure that the immediate future threatens neither a depression nor a recession.—*Princeton University Observatory, March 5, 1938.*

[The Catalog is fairly expensive.—*Ed.*]

Unpuzzling Color

Color Names Cause Confusion . . . A New System is Being Developed to Bring About Definite Standards . . . Like Sections of Grapefruit

By JOHN H. CRIDER

IN an age when science reproduces with dazzling accuracy the myriad colors of nature, we are inclined to take color for granted. Until related colors are examined closely, side by side, or until someone disagrees with us over the description of a color, we do not worry much about color names. After all, "what's in a name?"

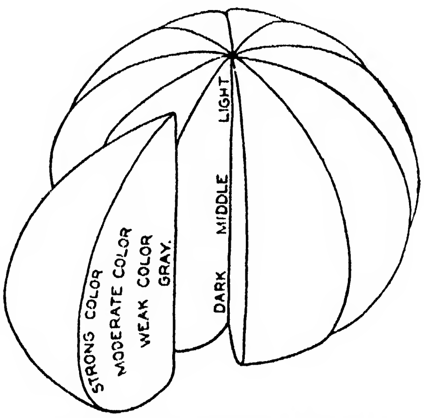
There is a great deal in a name when the name happens to be the only means people have for conveying a specific color designation. It is important, for example, that when you tell your decorator to make your drapes of *orchid* your decorator should have precisely the same idea of *orchid* as yourself. Orchids are flowers which derive much of their beauty from a blending of numerous colors. How, then, can different people be expected to associate the name *orchid* with a single color?

A color name might cause a lot of trouble, for example, if a lady had to depend upon ordering by telephone to match a new garment. Suppose she has a new *light green* sweater and wishes to order skirt, gloves, hat, and bag to match. Actually, she probably would have to shop for hours to match them properly, if at all. It would be convenient for her, and thousands like her, if *light green* always meant the same thing—if *purple* always could be *purple* and *blue* always *blue*.

The poets, of course, have license. They call colors what they like and there are no arguments. It's all in the interest of art. But for ordinary folk this question of naming colors is one that is controversial, argument-provoking.

THE ancient Egyptians managed to create some brilliant colors—so did the Chinese, Persians, and Indians—but it was not until the Germans popularized synthetic dyes, a process now highly developed in this country, that commercial use of color reached the baffling stage. The number of shades produced by our great dye companies is enough to make your head swim. Fortunately for the fashion creators, and unfortunately for the scientist, these shades or colors have to be named, otherwise how could the new vogues be sold to the public?

It is fortunate for the fashion creator because with industry's capacity for turning out new variations of color it is important that interesting new color names be kept before the consuming public. It is unimportant that none but a few experts can distinguish between



The color solid, reproduced by permission of the Munsell Color Company, Inc., is described in the text

the *coral* of this season and the *rose petal* of last year. The important thing, commercially, is to create consumer demand.

To the man of science this is a careless use of words. The multiplicity of color names is as provoking to him as it is pleasing to the fashion originator. Science requires precision. Names must always have the same meaning.

For the consumer the confusion of color names is perhaps worst of all. As long as people keep giving different names to the same color, arguments will crop up and dissatisfaction will be encountered. The average individual bases his use of color names on personal experience and everyone seems to have had a different experience.

Experts tell us that there are about 100,000,000 barely distinguishable colors. Very few people can recognize all of them; the difference is very slight. Only an expert paper grader can, for example, distinguish from memory more than 300 shades of white in paper!

To no group has this color puzzle been more troublesome than to your corner druggist who makes up prescriptions from a large variety of solid and liquid chemicals. He has two standard books to guide him—the National Formulary and the United States Pharmacopoeia. They describe each of the drugs your druggist uses, and one of the important means of description is by color. You can readily appreciate that the ability to recognize a chemical or drug by color would be most essential to those working in places where there are so many little bottles of powders and liquids which often mean life or death to stricken humans.

Thanks to the corner druggist, and to the national association of which he is a member, science has at last undertaken the job of solving the color name problem. In fact, the National Bureau of Standards in Washington, backed by the American Pharmaceutical Association, has just about finished the classification of the color names of powdered drugs; the naming of microscopic structures and crude drugs is well under way.

ALTHOUGH the project was instituted by the pharmacists, the system which has been worked out is capable of universal application. Already many other industries have evidenced an interest in the color name standardization project. It is hoped that through adoption of the new system by leading industries, the public generally will come to understand and use the new names. When that day comes, it will mean farewell to confusion in the naming of colors.

This standardization started 15 years ago when Dr. E. N. Gathercoal of Chicago threw up his hands in disgust over such terms as "blackish white," "reddish green," and "whitish." These virtually meaningless words and phrases had actually found their way into the official books. What was the poor pharmacist to do? Dr. Gathercoal found the answer by organizing a Color Convention in Washington. From this meeting the Inter-society Color Council was formed, and the job of scientifically standardizing color names was soon under way.

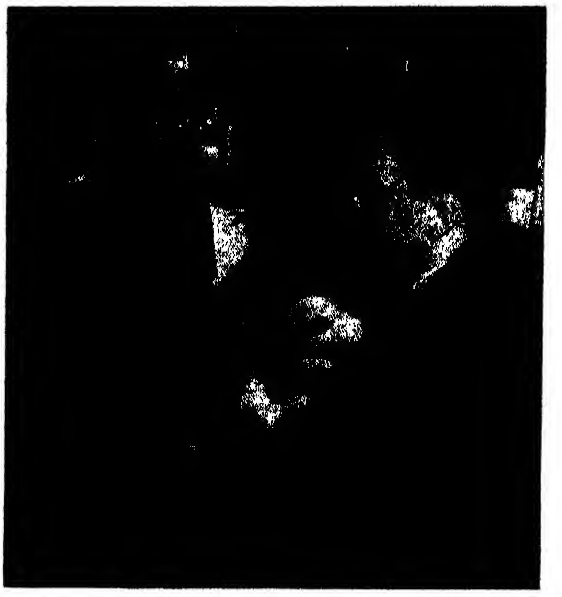
The object of the work at the Bureau of Standards, financed by the American Pharmaceutical Association, was to provide: "A means of designating colors in the United States Pharmacopoeia, in the National Formulary, and in general pharmaceutical literature; such designation to be sufficiently standardized as to be acceptable to science, sufficiently broad to be appreciated and usable in science, art, and industry; and sufficiently commonplace to be understood, at least in a general way, by the whole public."

Kenneth L. Kelly, research associate who has worked out the new system at

the Bureau of Standards with Dr. Deane B. Judd of that institution, believes that the objectives have been achieved.

The Munsell Book of Color was adopted as the basis of the new system. Under the Munsell System the colors are numbered but not named. It divides the color solid into 20 sections or segments, breaks the segments into pieces, and gives a number to each. The new color project went further and gave a name to each piece. The names in the new color system, like the numbers in the Munsell System, represent a range of color—not simply one color.

Below: Kenneth L. Kelly, research associate at the Bureau of Standards, who has been active in developing the new standards of color nomenclature described in the accompanying article, is shown here trying to determine by eye the proper color name for a powdered drug. The drug itself is compared with a color chart



Above: Confronted with a border-line case, Mr. Kelly makes use of the colorimeter, a device which makes it possible to measure differences in color which are visible to but can not be calculated by unassisted eyesight

The color solid, which is the foundation of the whole project, may be described as a grapefruit, the top white, the bottom black, with the color spectrum running around the middle as the Equator circles the earth. Theoretically, all of the known colors and shades of color are in this solid. The color namers, following the Munsell principles, broke the solid into sections, each section corresponding to the natural sections of a grapefruit. There are 20 sections and, as you can understand from the description of the solid, the colors in each one of these sections range in lightness from top to bottom (the darkest at the bottom), and in intensity from the center to the outer surface.

After the segments were broken into approximately equal pieces, still following the Munsell principle, the research workers were ready for their real job—naming the pieces. After considerable experimentation, they adopted 23 common English words as the words they would use in the naming system. Since the color solid had been divided into 320 pieces—about 16 pieces to a segment (some more, some less)—they had to put these 23 words into 320 combinations to describe the colors.

It is significant that there are no *midnight, schooner blue, leafmold, sistina, quimper,* or other such names among those selected. You may recall having seen some of the names just mentioned used in connection with feminine fashions or interior decoration. Words like these have meaning to the Textile Color Card Association of New York, which performs a great service to the textile industry by supplying such appealing names to newly created fashions. But to you, for example, what does *queen blue* mean? Compare such words to those used by the color namers at the Bureau of Standards. Here they are:

BASIC COLORS—Red, Yellow, Green, Blue, Purple, White, Black, Grey.

COMPONENT HUES—Pink, Orange, Olive, Brown.

MODIFIERS—Pale, Brilliant, Vivid, Faint, Dusky, Deep, Light, Dark, Weak, Strong.

THE ADVERB—Very.

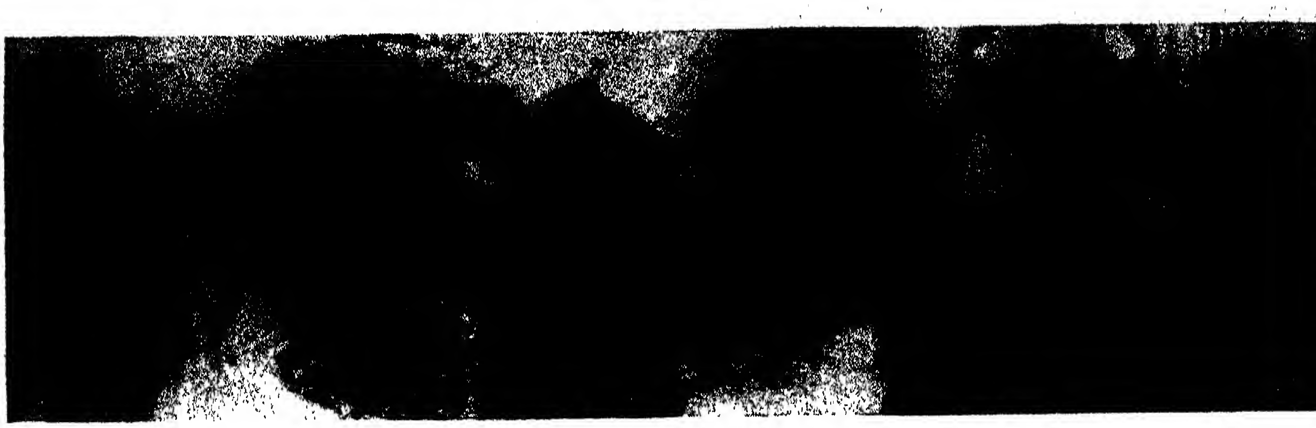
Having tentatively adopted these names—and the indications are that they will stick—the color namers then had to go through the National Formulary and the United States Pharmacopoeia to look at each of the drugs mentioned to see what color names from the new system correctly described them. Sometimes the same color had been named variously. There will be no more "blackish white" or plain "whitish," although the color namers are using the "ish" ending as a modifier of definite names, such as "reddish purple," "yellowish green," and so on. Such combinations have a definite meaning in the new word system, while formerly they were used simply to suit the fancy of the observer and with no relation to a standard system.

When the druggists' committee has completed checking the new color names which have been assigned to the drugs mentioned in the two books, it is expected that these accurate designations will be officially approved and adopted for use in future editions of these important volumes.

ANY visitor to the Colorimetry Section of the Bureau of Standards may see the namers at work, as well as the exhibits which they have prepared to illustrate their achievements. In one case the visitor will see three samples of the same drug from three reputable wholesale houses. The difference in color is obvious to anyone, yet in the National Formulary they are all classified as *Light Brown.* Under the new naming system tentatively adopted for these specimens, they will be called *light yellow brown, weak red brown,* and *brown,* respectively. The beauty of the system is that each name has a definite meaning. If there is any question about it all the questioner has to do is look at the color solid to see what color the name describes.

The system also has the advantage of being workable by anyone with good eyesight. In a few minutes' time a person understanding the system can definitely classify almost any color under the new system. When fine points arise, resort is had to the colorimeter, a machine which enables the worker to measure differences in color which are not calculable by the unaided eye.

When the results have been officially adopted *purple* will be *purple* and *blue* will be *blue.* Arguments over color will be solved at once by recourse to the color solid and the new naming system.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

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Chemical Engineer

Giant Strip Mill

THE largest, fastest, and most modern wide continuous strip mill in the world, Republic Steel's huge new 98-inch strip mill recently opened in Cleveland, is, in sheer size and in a thousand and one details, a masterpiece of engineering.

A colossus in an industry where machinery and equipment is commonly gigantic, the new mill embodies in its design every

Rolled strip steel being delivered from the newest continuous hot mill

technological improvement that the country's best mechanical, electrical, and metallurgical engineers have thus far developed in the art of processing steel. Recent improvements and developments in lubrication, hydraulics, welding, design of bearings and electrical control, which make possible the production of extra wide sheet steel at the terrific speeds employed in Republic's new mill, are featured throughout the plant. So, too, are latest advanced factory management practices and technique in the efficient handling of materials, in the metallurgical control of products being processed, in the coordinating of all mill operations, and in the establishment of safe, healthful working conditions for humans in the plant.

Maximum delivery speed of the hot mill is 2121 feet (more than two fifths of a mile) per minute. It can roll all finished widths from 30 to 94 inches and all finished thicknesses from 18 gage strip to half-inch plate. The plant has a nominal rated capacity of 70,000 gross tons per month.

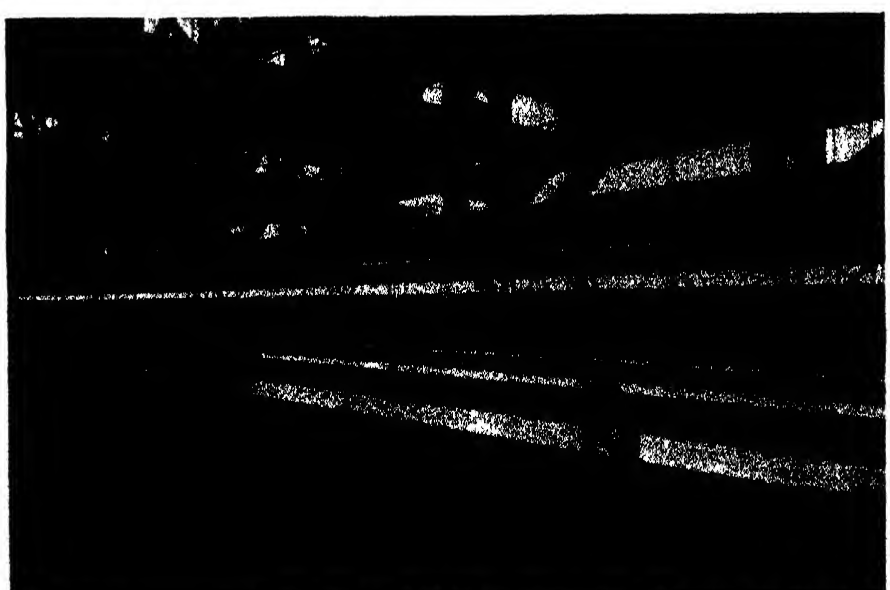
Binocular Magnifier

PRODUCT inspectors, proofreaders, botanists, artists, process workers, and many others who constantly use magnifying glasses of various kinds are always searching for more efficient or more convenient glasses for their work. They can get the convenience if not high power in the new Zeiss Binocular Head Magnifier which is distributed by the George Scherr Company. Since this device provides binocular vision, is worn before the eyes in a manner somewhat similar to the way spectacles are worn, and

For use where binocular magnification is essential to aid the vision

since stray light is excluded by the molded frame, both a stereoscopic effect and enhanced visual acuity are given.

The magnification of the binocular head magnifier is 2.25, which is ample for most



Steel is gaged on this transfer table on its way to finishing

fine work. The field of vision is about seven inches and the working distance is about eight inches. No focusing or adjustments are required, as the magnifier is suitable for use with any vision.

TAXES

ONE oil company reports, for 1937, payment of 104,909,408 dollars in taxes against 23,319,728 in dividends. This figures out per share of stock at $9.65 for taxes and $2.25 for dividends.

Acreage Determined by Weight

A NOVEL method of ascertaining acreages of crops and other vegetation, by using aerial maps, was employed by the Bureau of Agricultural Engineering in surveying the basin of the Rio Grande in Colorado, New Mexico, and western Texas for the National Resources Committee. A total area of more than 2,000,000 acres was mapped in 18 classifications in a single season, with only a small force and limited funds. The system was devised by F. C. Scobey, of the Irrigation Division, Bureau of Agricultural Engineering.

Practically all the basin was mapped on aerial photostatic prints having a scale of two inches to the mile in the more open country and four inches in the more congested areas in New Mexico. On these prints the fields were readily identified and numbered or colored according to the classification scheme.

To obtain totals of areas so identified, the field maps were traced on clear celluloid sheets, which were then cut up along boundary lines. The pieces for each classification were weighed, in groups, on laboratory balance-scales. These weights were converted into acreages by comparison with previously ascertained weights of templates or accurately dimensioned unit samples of the celluloid.

A pattern sheet consisting of a template of heavy celluloid, representing 1000 acres at the two-inch scale and 250 acres at the four-inch scale, was cut out and carefully trimmed to exactness with a file, fine drafting scales being used to determine dimensions. One of these test blocks was cut for each field sheet.

A direct check on the weighing, and thus on the summation of areas, was made for each field sheet. Before being divided, the piece of celluloid covering the field sheet was carefully weighed. When all the areas and the test block had been broken out, the fragments remaining also were carefully weighed.

The sum of the weights of scraps, plus the group-pieces, plus the test block, had to equal the weight of the original piece of celluloid. A tolerance of 1 part in 1000 was adopted. If the lack of agreement exceeded that ratio, weighings were repeated until the discrepancy was found.

Paper mill requirements necessitated the construction of this huge tank

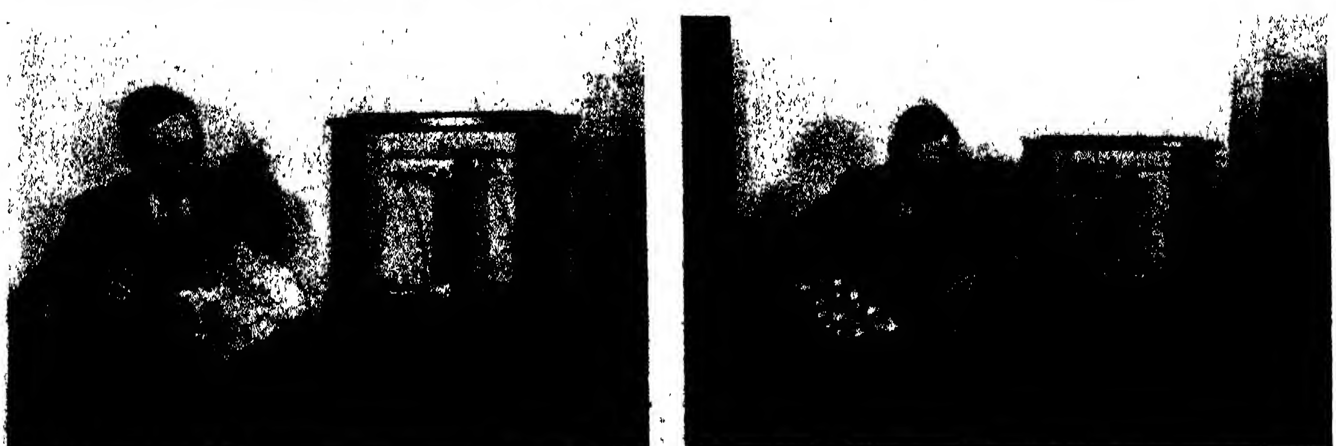
Huge Reinforced Concrete Tank

CONSTRUCTION of a reinforced concrete, filtered-water storage tank of 1,500,000-gallon capacity to serve the Crown Willamette mill of the Crown Zellerbach Corporation at Camas, Washington, has been completed by The Austin Company. It is situated on the Columbia River, about 40 miles from Portland.

In order to meet requirements of this mill, one of the largest pulp and paper producing units in the northwest, with a concrete tank suitable for long, continuous service, the Hewitt system of concrete tank design was employed. The result has been a tank costing approximately 30,000 dollars, considerably less in cost and claimed to be more permanent in structure than others of comparable size built in accordance with usual engineering practice.

Under the patented Hewitt system, the tank walls were constructed in vertical sections. Recesses are provided for in the forming of wall exteriors, to permit attachment of turnbuckles to the circular rods which are placed after the tank walls and the dome have been completely poured. Spacing of these rods is provided for in the design and they are taken up with special tools to provide specified initial stress in the rods and in the concrete. The turnbuckle rods are covered over with gunite after the adjustments have been made. In this way the concrete is placed in compression, and difficulties caused by expansion and contraction are reduced to a minimum.

Particularly interesting in The Austin Company's work at Camas were the sequence and method of applying the Hewitt system. The site, on a heavily wooded hillside, was cleared, excavation completed, and the concrete foundation ring and floor then poured. Then an inside form, 1/7 of the inside circumference of the tank, was constructed. This form was braced back to a king-pin in the center of the floor and was constructed on rollers. Sectional forms for the exterior of the tank were built up so that they might



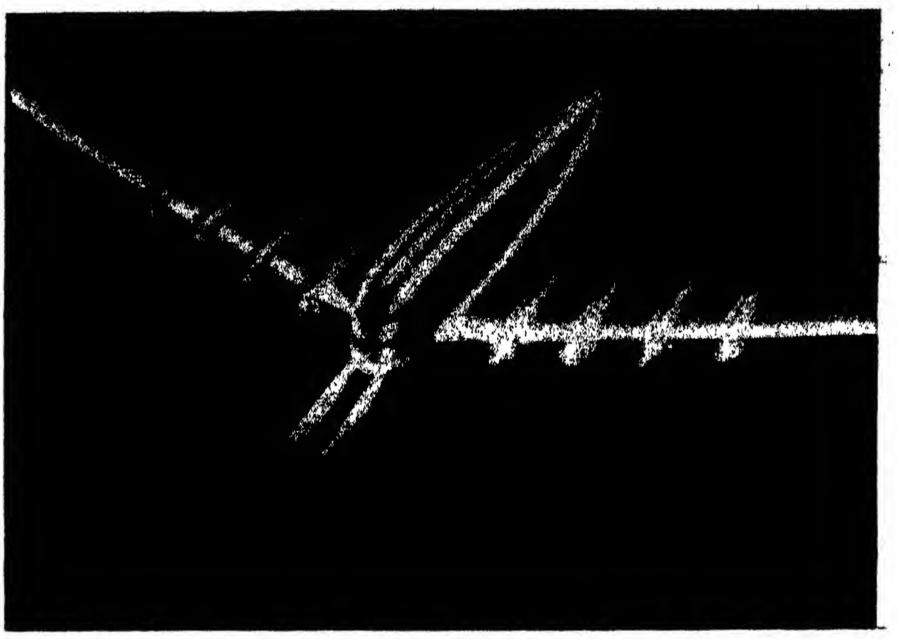
Sections of celluloid, cut from map tracings and weighed, determine crop or woodland acreages

be readily handled from a traveling A-frame, which ran on a track provided at the top of the tank on the movable form section. The inside movable form was pulled away from the wall by a chain block when the concrete had set in a completed section, and then rolled to the next position. A movement toward the center of the tank of approximately four inches was provided for by a slot in the horizontal bracing connecting the form to the king-pin. Accuracy in establishing the proper position of the inside form was assured by its position with respect to the king-pin and slot, as well as by a line scribed on the floor of the tank.

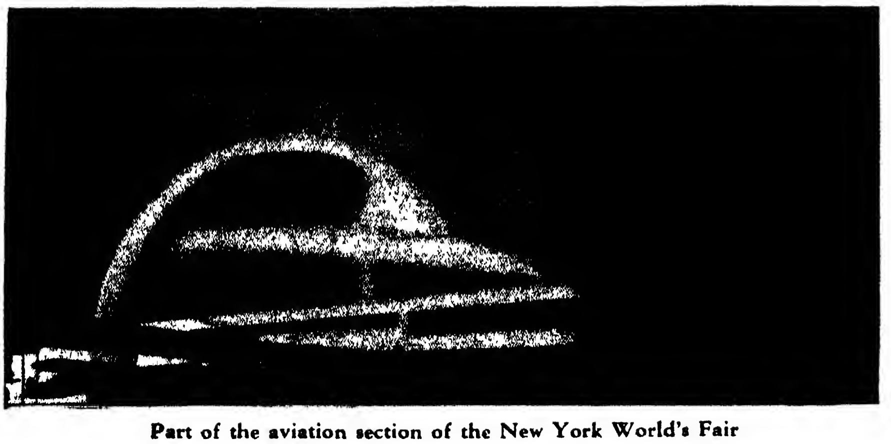
The tank is 24 feet high at the side walls and 36 feet in the center and has an inside diameter of 106 feet. A total of 1200 barrels of cement was employed on the job.

Imagination

Architects and industrial designers have given free play to their imagination in the aviation section of the New York World's Fair. The aviation building, designed by William Lescaze and J. Gordon Carr, will have a huge awning-shaped entrance, and is well calculated to give the impression that the visitor is at a large and modern airport. At "anchor" in front of the building will be found one of the largest "Clipper" flying boats. On entering the building, the visitor will find himself in a high, wide chamber with arching roof rising at its far end to a height of nearly 90 feet. A persistent and familiar drone will assail his ears. Invisibly suspended from the roof he will see a huge transport plane, with lights flashing, propellers whirling. Moving clouds and glowing sunlight on the wall behind it will complete the illusion that the plane is in flight.



The artist's airliner of the future does not meet with complete approval



Part of the aviation section of the New York World's Fair

One of Raymond Loewy's models in the Transportation Building will picture the airliner of the future. It is rather curious to see what an artist imagines the plane of the future to be like. According to the drawing it will have eight engines mounted in nacelles at the leading edge of the wing. Let us point out to the artist that the engines in the ship of the future will disappear completely inside the wing. The drag of eight engine nacelles will never be tolerated. Again, in a plane of this size, the fuselage will certainly not be allowed to project so far above the wing, nor will it have so blunt a bow. On the other hand, the artist is perfectly right in making the fuselage very much shorter than in the conventional airplane of today. That is certain to be the tendency as the years go by. We are really tempted to attempt an imaginative drawing ourselves! Yet, at the same time, the general impression created by Mr. Loewy is certainly one of beauty, power, and speed. *A. K.*

Scientific Pilots

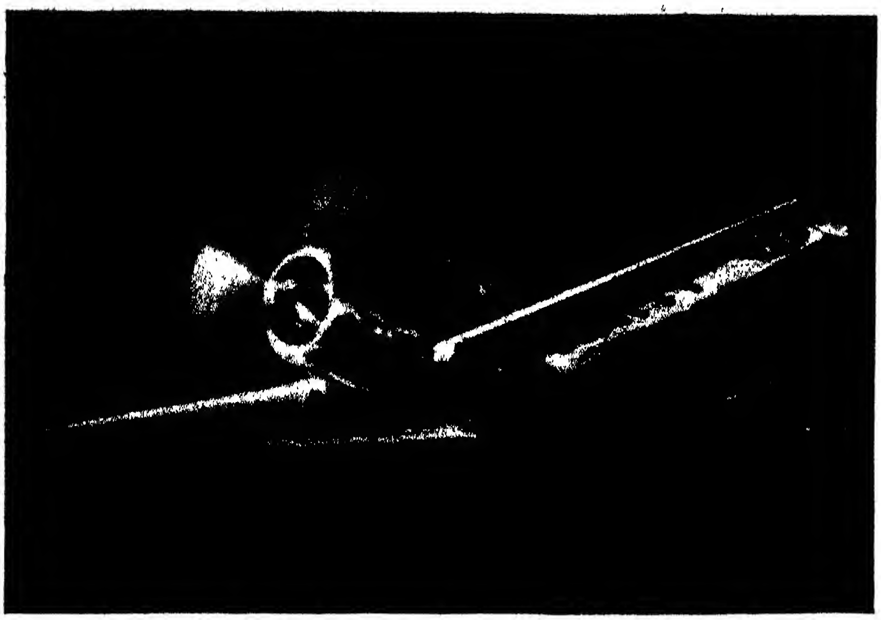
The tendency of transport operators is to demand more and more knowledge from their pilots. Courage, calmness in emergencies, and instinctive flying skill are no longer sufficient. Transport pilots must understand radio signals, complicated air regulations, blind flying instruments, and a dozen other topics. Also, they must follow flight plans and know precisely how to regulate their engines so as to secure maximum fuel economy. As a part of the effort to secure fuel economy they must know exactly the horsepower delivered by the engine at a given altitude, a given revolutions per minute, and a given pressure in the manifold (which varies with the degree of supercharging).

Unfortunately, the pilot has no time to look up curves or to use a slide rule. To ease the pilot's job, the manufacturers of the Wright Cyclone engine now provide a special Cruising Power Calculator. The calculator is marked off with horsepower at the left, inches of manifold pressure in mercury on curved lines, and revolutions per minute on diagonally inclined lines. The case of the card which carries these indications is of celluloid, and its top diagonal edge slopes appropriately with the characteristics of the engine. This diagonal edge is marked off into 20 divisions, each corresponding to an altitude of 500 feet. The pilot slides the card in or out until the edge of the celluloid meets the intersection of a given revolutions per minute and a given manifold pressure. He then reads power at the left, and altitude on the celluloid scale. The whole process can be learned in a few minutes at most. The usefulness of the Cruising Power Calculator has been demonstrated by the fact that 4000 of them have been supplied to date. —*A. K.*

Midget Aircraft Radio Transmitter

The new Civil Air Regulations of the Department of Commerce, which we have already had occasion to discuss, are likely to increase the safety of airline operation, but they will also make life exceedingly hard for the private flier, particularly when he is trying to fly anywhere near the airways. It would appear that every private flier will have to have two-way radio at his disposal, and, what is more, know how to use it so that he can keep in touch with the control officers at the airports. Com-

A scientific pilot makes use of the new engine power calculator



A modern Army pursuit ship, analogous to the P-37 described

The first application of the Direct Current Selsyn has been to give to the pilot an indication of flap and landing gear position. The advantages of such indicating devices to the pilot are obvious. The complete system, of four transmitters, necessary electric wiring, and one four-element indicating unit weighs only 35 ounces.—*A. K.*

Curtiss P-37 Pursuit

THE Army Air Corps has just purchased a number of Curtiss P-37 pursuit airplanes, which incorporate all the latest devices—enclosed cockpit, a steerable tail wheel, flaps, and landing gear retractable into the wing. But perhaps its greatest claims to attention are the top speed, which is well over 300 miles per hour, and the fact that for the first time in several years a fast Army pursuit ship has been equipped with a liquid-cooled engine. By the use of such a power-plant, the nose of the ship becomes considerably neater than the nose of an air-cooled job, even when provided with a streamline cowling, and the vision is greatly improved. With chemical cooling of the engine, the radiator becomes quite small and can be neatly tucked away against the side of the fuselage. Except for the engine, the P-37 is similar in many respects to the plane illustrated in the photograph at the left, above.—*A. K.*

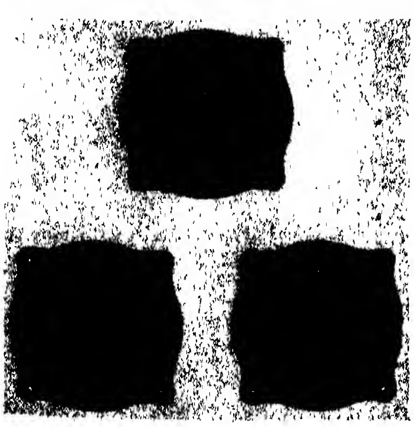
panies building aircraft radio equipment are therefore giving considerable attention to the problem of supplying the private operator with light and simple apparatus for use on his plane.

It is remarkable what the electrical engineers can do in this direction. Thus, Westinghouse announces a new midget transmitter known as the 25 A, which weighs only 25 pounds complete with its audio-power unit, radio frequency control units, and ability to deliver 15 watts carrier power to a suitable antenna. Arranged for frequencies of 3105, 3120, and 6210 kilocycles, it will also transmit on any of the 42 airline frequencies for which the plane is licensed. Shifting from one frequency to another in flight is simple, and constant frequency is readily maintained. A built-in relay permits the same antenna to be used for both transmitting and receiving. A push button on the microphone controls the two-way communication feature, being pressed while the user is talking and released while he is listening. Either telegraph or telephone transmission may be employed. Installation is easy, and the complete unit measures only 7¼ inches in width, 5 inches in height and 4¾ inches in depth.—*A. K.*

In the shop where the *DC-4* is nearing completion

Help in Landing

SELSYN is a well known trade name for a system of transmitting the indications of an instrument to a distance. The instrument turns a rotor at one point and through electrical communication a rotor at a distance turns in exactly the same manner. The Selsyn system of instrument-reading transmission has hitherto been possible only where alternating current was available. On board the airplane, alternating current is not provided, as a rule, and 12-volt direct-current batteries are apt to be the only source of supply of electricity. Now General Electric engineers have developed a method whereby Selsyns can operate on direct current, so that they may be adapted in aircraft work.



An aid in airplane landings

Two devices are used in a Selsyn system: one which operates at the sending point is called the transmitter; the other at the receiving point is called the indicator. Wires from the transmitter are connected to the coils of the indicator. As the transmitter turns, it changes the strength of the current in the wires. This change in turn alters the character of the magnetic field at the receiving end, and the indicator (a rotor of the permanent magnet type) rotates freely to take up the position of "minimum magnetic reluctance." Thus the transmitter and indicator rotor move in perfect harmony and accurate indications are given.

Douglas "DC-4" Nearing Completion

THE Douglas *DC-4* has been engineered and is being built to the order of the five biggest airlines in the United States. The huge four-engined monoplane is nearing completion, and gives every promise of success. It will have a gross weight of 65,000 pounds, will utilize every new development, and will ultimately be equipped with supercharged cabins for use in the "sub-stratosphere." Parties to the contract (dated March 23, 1936) were United Airlines; T. W. A., American Airlines, Pan American, and North American Aviation. To date, the enormous sum of 1,500,000 dollars has been spent in development work and more than 500,000 engineering hours will go into the design and supervision of the complete construction.

In addition to a crew of five, the *DC-4*

will carry 42 passengers. Its wing span will be 138 feet 3 inches, its length will be 97 feet, and it will tower 24 feet above the ground when supported on its landing gear. At take-off the four engines will deliver 5600 horsepower. Cruising range will be 2200 miles, and cruising speed at the most efficient altitude will be 240 miles per hour. The highest mountain in the United States will be cleared by a 5000-foot margin. The useful load will be 20,000 pounds with 6500 pounds of mail and express in addition to the passengers and crew.

We have often spoken of nose wheels or tricycle landing gear. So efficient has this type of landing gear proved on smaller ships that Douglas engineers had no hesitation in adopting it for the new giant.

Wind-tunnel tests, hundreds of structural tests, and the most refined calculations have gone into this ambitious enterprise. The artist's drawing gives a splendid conception of the size of the ship and the methods employed in the task of final assembly.—*A. K.*

To Detect Enemy Aircraft

To detect enemy aircraft, flying at night without lights, Army engineers are using a delicate heat detector or radiometer, similar to the radiometers used in detecting the heat of distant stars. The aircraft may not carry lights, but the heat of their motors cannot fail to betray them. Experiments made at Fort Monmouth, New Jersey, have been entirely successful in spotting aircraft flying in complete darkness.—*A. K.*

The Airport Orientator

INVENTED by Horace Stark of the Pennsylvania-Central Airlines, and developed by the Sperry Gyroscope Company, under an order from the Department of Commerce, the Airport Orientator will free the pilot from many headaches.

In the conception of this instrument, Mr. Stark argued that it would be highly desirable for the pilot always to have a chart available which would show him the exact location of the terrain beneath him, no matter in what direction his plane might be heading. This he achieved by using a circular chart, one of which was made for each terminal airport en route, as well as for alternate airports. The chart is so light and so mounted that it is controlled by the directional gyro, and is always set to the true geographic north without affecting the directional gyro in any way. This chart is shown on top of the instrument in one of our photographs. Besides the airport, there are shown the directions of the radio beams. With this instrument the pilot is certain of heading either towards the station or directly away from it. It then becomes quite easy to make a desired maneuver towards the airport, without any complicated mental calculations.—*A. K.*

"Headache saver"

Keeping Fish Fresh

BY dipping fresh fish fillets in a 0.3 percent solution of hydrogen peroxide before packing in ice an increase in the keeping period of as much as three to six days has been realized. No change in the appearance, odor, or flavor of the fish is caused by the treatment.—*D. H. K.*

Pickwick Dam Thrust Bearings

MORE than 6500 gallons of oil will be used to dissipate the small amount of heat generated in the two giant thrust bearings that will form a part of the generating units at TVA's Pickwick Landing Dam power plant.

Approaching completion as the fourth in the chain of the Tennessee Valley Authority's river control projects, the dam at Pickwick Landing, Tennessee, will harness the river to two water-wheel generators, each capable of developing approximately 48,000 horsepower.

Smoothing the running surface of the world's largest thrust bearing

The largest thrust bearings of this type in the world will be required to carry the weight of the moving parts in the generators and water-wheels, and the thrust of the water, a load of about 2,500,000 pounds or 1250 tons. The generators and bearings are being built at the East Pittsburgh works of Westinghouse.

For this weight-carrying job, Westinghouse engineers designed the bearing on the pattern of a giant washer with a diameter of 105 inches.

In order to shoulder its load, the bearing has an under surface or running plate of highly polished cast iron resting on 10 bearing shoes, the whole being submerged in a bath of oil which forms a film between working surfaces so that the rotating parts literally float on oil.

To aid in dissipating the small amount of heat generated in each bearing, water-cooling coils will be immersed in the oil, through which will be circulated cold water at the rate of about 100 gallons per minute.

Mercury Vapor Detector

MERCURIAL poisoning is the serious and sometimes fatal result of absorption and retention in the body of even a small amount of metallic mercury. It has been found that, in the greatest number of cases, such poisoning is due to inhalation of vapor released by the metal at ordinary temperatures.

To detect mercury vapor

Workers in many fields are exposed to the possible presence of vapor in manufacturing processes where mercury is used, even where elaborate ventilating systems and other precautions are employed, and to meet this insidious challenge the Mercury Vapor Detector was created. It has been placed on the market by Mine Safety Appliances Co. The instrument plainly indicates the presence of mercury vapor in air, even in infinitesimal amounts.

The M.S.A. Mercury Vapor Detector is based upon the property of selenium sulfide to darken when exposed to metallic mercury vapor. The degree of darkening depends upon the mercury vapor concentration, the velocity of air passing over the sensitive surface of selenium sulfide, the temperature of the air, and the length of exposure.

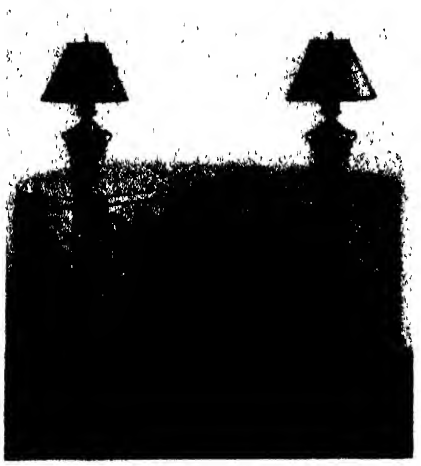
The Detector proper consists of a metal truncated cone with a 25-watt red Mazda lamp contained in the base and a curved paperholder fastened to the top. The cone, which acts as a chimney, carries air—heated by the lamp to a reasonably constant temperature—upward past the holder containing a strip of selenium sulfide paper. To prevent air other than that in the chimney from striking the paper, a cross-draft eliminator is provided in the form of a cylinder mounted around the holder. An observation window renders the paper easily visible at all times, and the eliminator is removable for access to the holder.

The positive, tested method employed in this apparatus is fool-proof and precise. A simple comparison of the darkened sensi-

tised paper with a color chart gives an easily-read warning of the mercury-vapor content of the air under test. So sensitive is the method that it is possible to detect one part of mercury vapor in 100,000,000 parts of air by an eight-hour exposure—which is equivalent to .082 milligrams of mercury vapor in each cubic meter of air.

Shell for Interior Decoration

THERE are so many new materials and new forms of old ones clamoring for the attention of the architect and the interior decorator that we are inclined to forget that



Decorated with kapa shell

certain natural products can be made into forms that will, in some respects, be superior to the synthetic variety. Of the few new natural products that are being offered today, kapa shell is one of the oddest and, at the same time, a most attractive decorating material. After being processed, it is a pearly, pliable scale resembling a three-inch fish scale, and may be laid on flat or curved surfaces to give an iridescent pattern.

Kapa shell comes from the Philippines and is processed in the United States by J. C. Edgar, sole producer. Stiff when collected, the kapa shells are boiled in secret chemicals until they are pliable and have a pearly translucent sheen. They can be given a variety of colors including gold and silver. Applied to overlap like miniature shingles, they provide a moisture-proof, non-flammable surface for entire walls or inserts, ceilings, bath rooms, elevator cabs, furniture, and the like.

Removing Fluorine From Drinking Water

BECAUSE calcium fluor-apatite is much less soluble in water than calcium phosphate, the latter has been proposed as a method of removing fluorine from water to prevent mottling of the teeth, a trouble caused by the intake of that chemical in drinking water. By merely adding a small amount of tricalcium phosphate to water containing fluorine, or, by passing the water through a bed of granulated tricalcium phosphate, dangerous waters can be made safe. Like many other important discoveries, this one has been made by two groups of investigators at very nearly the same time. One of these groups was working on problems of the Tennessee Valley Authority at the University of Tennessee, and the other in the laboratory of the Victor Chemical Works in Chicago. The value of the method, particularly on account of its simplicity, is great, whichever of the two groups may finally be awarded credit for it.—*D. H. K.*

New Automatic Humidifier

THE small humidifying unit shown in one of our illustrations, with a capacity of 1½ pints of water per hour, has many adaptations in industrial, commercial, and domestic fields, according to the manufacturer. The introduction of one or more units will serve as a partial air conditioner and meet any desired humidity specifications, and because it can be tapped into the regular water supply or storage tank, there is no necessity to install special equipment to handle water.

Mounted inside the spun-copper bowl, which forms the housing of this unit, is a waterproof motor. It drives a mechanism to break water in the bowl into finely divided mist and mixes it for delivery with sufficient air to complete vaporization. The vapor rises from the top of the bowl, as indicated in the illustration. This bowl measures 13½ inches in diameter by 11½ inches high, and the complete unit weighs but 35 pounds. It can be placed on a table or suspended from wall or ceiling.

Makeup water is supplied through a small connection in the side of the bowl, the connection being equipped with a brass float-valve, employing a valve cap containing a live-rubber disk which fits over the water inlet. Its operation is controlled by a Friez-humidistat with a range of 10 to 100 percent, and a working range of 10 to 85 percent, at temperatures from 40 to 150 degrees Fahrenheit. The humidistat is mounted on the side of the bowl and is wired for 110 volts, 60 cycle alternating current.

Humidity as required

Even Milk is Not Always Beneficent

MILK contains over 300 times as much organic matter as sewage and is, therefore, capable of creating far more serious conditions of nuisance in streams, and complications in operating problems in a municipal sewage treatment plant.

The solids content of average domestic sewage is about 800 parts per million, more or less, depending on the total solids content of the water supply. The volatile or organic solids of such sewage, which are more nearly a criterion of its nuisance-producing power, amount to about 400 parts per million. The total solids in whole milk, on the other hand, amount to about 130,000 parts per million, of which 123,000 parts per million are organic. Even in diluted milk wastes from a milk receiving station, such as washings from cans, floors, equipment, and the like, the normal milk solids content frequently amounts to approximately 1300 parts per million, of which 1230 parts per million are organic. The biochemical oxygen demand (amount of oxygen necessary to oxidize and stabilize the organic constituents) of such wastes is several times greater than that of ordinary domestic sewage.—*Health News* (New York State Department of Health).

FUNNELS

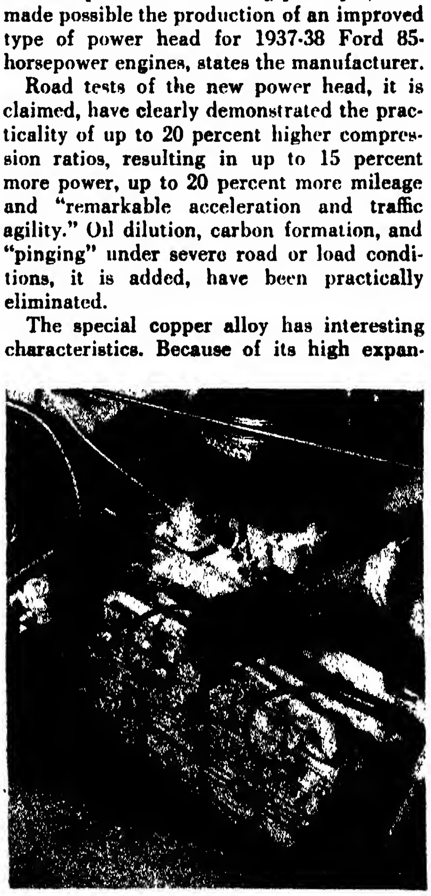
TO save weight and to prevent corrosion, aluminum alloy funnels will be used on the new 30,000 ton Cunard White Star Liner, *Mauretania*. She will be the first of her size to have such funnels.

Copper-Alloy Automobile Engine Head

FURTHER developments in the copper alloy used in the production of the Thermo-Flow power head, manufactured by the Federal-Mogul Corporation, and use of a new "spot and fin" cooling principle, have made possible the production of an improved type of power head for 1937-38 Ford 85-horsepower engines, states the manufacturer.

Road tests of the new power head, it is claimed, have clearly demonstrated the practicality of up to 20 percent higher compression ratios, resulting in up to 15 percent more power, up to 20 percent more mileage and "remarkable acceleration and traffic agility." Oil dilution, carbon formation, and "pinging" under severe road or load conditions, it is added, have been practically eliminated.

The special copper alloy has interesting characteristics. Because of its high expan-



The new alloy head installed

sion coefficient and substantial elongation, it cannot crack due to over-heating, freezing, or sudden chilling, a problem faced by all highway haulers and many motorists in sections where extreme temperatures or mountainous driving are encountered.

It is also of unusual interest to note that the high heat conductivity of this new copper alloy is such that it cannot be cut by an acetylene torch; the heat flows away from the point of contact of the torch too rapidly to build up a melting heat.

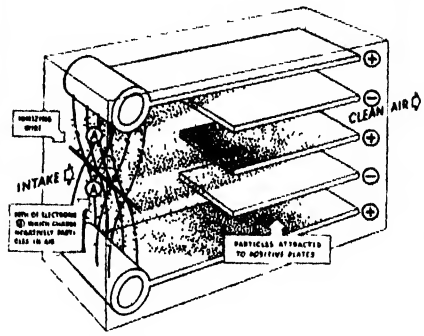
The use of the new head has already extended to truck and bus fleets—the former because of the extra power offered and economy both in fuel and maintenance, the latter, because stop-and-go driving makes high acceleration extremely desirable; economy is also a factor. The extra power, speed, and economy interest police and fire departments and ambulance operators because additional speed and unusual traffic flexibility are essential in emergency service.

Modern Retail Store Pioneers in Use of 99% Clean Air

THE first retail store to utilize air freed of 99 percent of all dust particles is the newly opened and ultra-modern F. W. Woolworth and Company store at 39th Street and Fifth Avenue, New York City. In this pioneering installation, all air for the store passes through the "Precipitron," an electrical air-cleaning device developed by Westinghouse research engineers, which removes 99 percent by weight of all particles in the atmosphere, even those as small as four-millionths of an inch in diameter. This installation will enable New York shoppers to breathe almost pure air for the first time.

In the area surrounding the new Woolworth store, it is estimated that dirt is deposited out of the atmosphere at the rate of 100 tons per square mile annually. In a year's time hundreds of bushels of atmospheric impurities, of which about 90 percent will consist of particles no bigger in diameter than the hundredth part of the width of a human hair, will be collected on the plates of the Woolworth "Precipitrons." By weight, engineers estimate this collection will consist of one-third ash; another third of fixed carbon, such as soot, lampblack, and other derivatives; and the remaining third made up of volatile matter such as oils and greases. Sulfur, bacteria, pollen in season, and many other substances found in the atmosphere of any city, will also be deposited. Every month, or as often as needed, the dirt collection will be washed off the plates down the sewer; a collection of harmful substances removed which otherwise would have been breathed within the store or deposited on the walls and store stock.

In the clean-air system described below, the air enters through an intake (right in photograph at the right) passes through the ionizer cells (left in photo at right), where it is freed from dust, and then enters the store through the grille at left in photograph at the left. *Below:* Drawing shows in simplified form the construction of the air-cleaning cells, and indicates direction of the flow of air through them



The air inside the new Woolworth store is said to be purer than any ocean breeze. In the cleaning process, the air is first bombarded by ions—minute electrical charges—emitted by wires as fine as human hairs which carry a charge of 12,000 volts. The ions attach themselves to particles in the air, thus giving the particles an electrical charge. Next, the treated air is drawn through a series of coils consisting of alternately spaced high-potential and grounded plates. By charging the high-potential plates at 5000 volts, an electrical field is established. As the treated air passes through these cells, the charged particles adhere to the plates and the air, now cleansed of all solid matter, passes on through ducts that lead to the areas being served by the equipment.

Physicians have already tested the reactions of hay fever and asthma patients to electrically cleaned air. Those with hay fever caused by breathing pollen-laden air found almost immediate relief. Asthma sufferers whose troubles result from breathing the dusty air of cities also have been aided. Certain types of sinus ailments likewise yielded, and continuing laboratory work is expected to develop more data for treatment.

New nickel-molybdenum-steel shovels are so tempered that they are extremely flexible. They may even be clamped in a vise (*above*) and bent as shown, yet will spring back to original shape when released. Users can see many resulting advantages

FRONTIER

DIXIE will be the chemical frontier of the nation during the next quarter century, according to Dean Frank C. Whitmore, of Pennsylvania State College. The raw materials the South will supply include sugar, petroleum, sulfur, natural gas and coal, cellulose, starch, and vegetable oils.

Better Glass Stoppers

GLASS stoppers used in bottles containing chemical reagents have a disagreeable tendency to stick but they have been used because no better closure could be had. A recently patented combination stopper avoids sticking, is completely interchangeable from one bottle to another, and has only glass in contact with the bottle's contents. This stopper consists of a flat glass disk held in place against the ground neck of the bottle by a plastic screw cap. Experience with these closures has proved highly satisfactory. They are much cheaper than ground-glass stoppers—*D. H. K.*

Cigarettes Filter Tobacco Smoke

SEVERAL readers have written to us asking whether it is true that the widely sold Zeus cigarette holder, employing a complete cigarette as a filter, actually removes nicotine and other products of combustion from the inspirated smoke. The answer is: "Yes, a very large percentage of them." This is shown in recent careful and authoritative research.

When this filter-holder was first developed as a result of discussions between Count Giuseppe Cippico, who now heads the Zeus

Corporation, and Mr. Arthur Davis, Chairman of the Board of the Aluminum Company of America, tests showed that it filtered out an average of over 50 percent of the nicotine in tobacco smoke. These tests were conducted by chemists in the Aluminum Research Laboratories. Since then, the holder has been improved so that now all smoke must pass through the inserted filter-cigarette, and the nicotine-removal percentage correspondingly raised. An official report rendered by the Laboratories of the Italian Government Tobacco Monopoly states that the holder with a single filter-cigarette removes 70.5 percent of the nicotine, and the one with two cigarettes removes 93.8 percent.

While this scientific development may seem an obvious one to laymen, it is the result of considerable research. The aluminum barrel, for example, was not a mere haphazard choice for the sake of convenience; it was selected because a metal of high heat conductivity was needed so that the volatile substances in the smoke would cool rapidly and be deposited within the filter cigarette.

DRIVERS

ALTHOUGH the accident repeaters among automobile drivers constitute less than 4 percent of the driving population, this small group is responsible for nearly 40 percent of the automobile accidents in this country. Much of the study of the accident prevention problem should therefore be concentrated on these individuals.

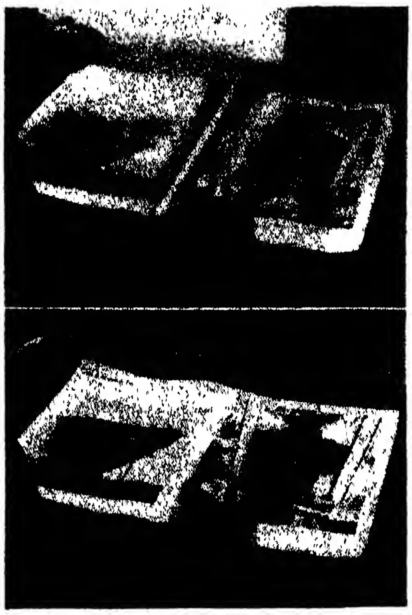
Polaroid for Desk Illumination

An entirely new type of illumination completely free from reflected glare was recently shown to the public when Polaroid Lighting, Inc., introduced the first lighting unit of this type, a desk lamp.

Polaroid, the material effecting this control of light, is the invention of the Boston scientist Edwin H. Land. It has also been mentioned as the solution to the problem of eliminating automobile headlight glare, and has been used in sunglasses.

Mr. Wheelwright, of the Land-Wheelwright Laboratories, explains the action of Polaroid as used to eliminate glare in illumination. The accepted scientific version of many aspects of ordinary light is a series of waves vibrating in all directions at right angles to the light beam. Light waves vibrating up and down penetrate the paper and ink when they meet the reading surface and come out with the color message and detail. Other light waves, vibrating from side to side in the same beam, strike the paper horizontally and glance off the surface as a stone does when skipped on water. These latter waves represent the glare which conflicts with useful light and impairs vision.

The first Polarized lighting unit, intended primarily for desk use



Ordinary lighting of a magazine (*top*) and resulting glare. *Bottom:* Same, lighted with polarized light

Polaroid acts as a selector, letting through the vertical waves but shutting off the horizontal ones that cause glare. With glare eliminated, other lighting problems can be solved, he pointed out. The light source may be placed directly in front of the reader, thus assuring even distribution of light across the page without concern as to reflections. While the reader has no sense of brightness with Polaroid illumination, much higher intensities can be maintained.

Professor Robert W. Wood, regarded as the greatest American authority on optics, has said of Polaroid: "It is the most significant invention in the field of optics, certainly within the last generation, probably in the last century."

Marihuana More Dangerous than Heroin or Cocaine

MARIHUANA is "a more dangerous drug than heroin or cocaine." Authority for this statement is United States Commissioner of Narcotics H. J. Anslinger. Mr. Anslinger's statement was made as part of a report on narcotics appearing in the bulletin of the Federal Bureau of Investigation.

"I am surprised to learn that certain police officers have been inclined to minimize the effects of the use of marihuana," *Science Service* quotes Mr. Anslinger. "These officers should review some of the cases that are reported to the Bureau. They would, I am sure, be convinced that the drug is adhering to its Old World traditions of murder, assault, rape, physical demoralization, and mental breakdown. A study of the effects of marihuana shows clearly that it is a dangerous drug, and Bureau records prove that its use is associated with insanity and crime."

Effects of marihuana, according to an authority quoted by Mr. Anslinger, are as follows:

"1. Feeling of unaccountable hilarity.

"2. Excitation and a disassociation of ideas; the weakening of power to direct thoughts.

"3. Errors in time and space.

"4. Intensification of auditory sensibilities, causing profound dejection or mad gayety.

"5. Fixed ideas; delirious conviction. This is a type of intellectual injury so frequent in mental alienation. The user imagines the most unbelievable things, giving way to monstrous extravagances.

"6. Emotional disturbance during which the user is powerless to direct his thoughts, loses the power to resist emotions, and may commit violence which knows no bounds when disorders of the intellect have reached a point of incoherence. During this dangerous phenomenon, evil instincts are brought to the surface and cause a fury to rage within the user.

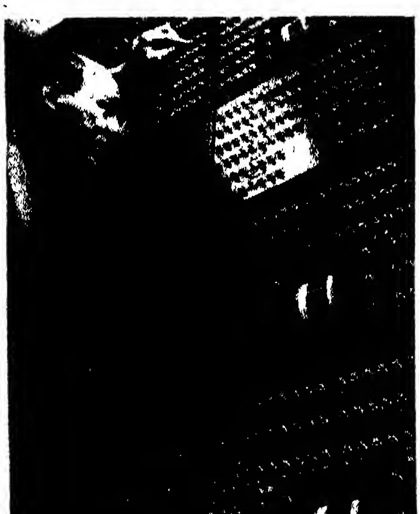
"7. Irresistible impulses which may result in suicide.

"The illusions are those of sight, hearing, and sense. The mind loses all idea of space and extent, and tends to exaggeration in all things; the slightest impulse or suggestion carries it away."

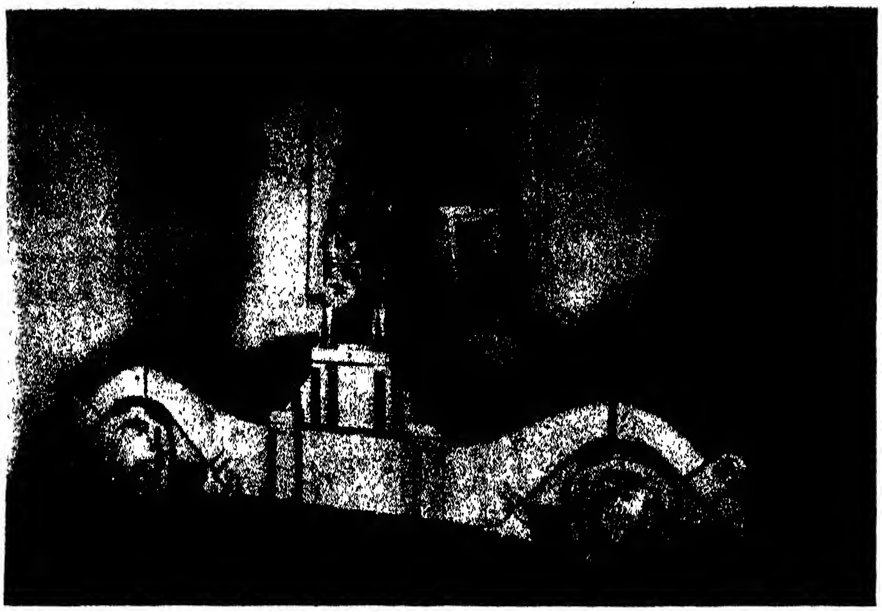
Calculator Saves Millions

ENGINEERS completed recently their 184th "inspection trip," covering thousands of miles of the nation's power systems without moving outside their laboratory in the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company.

The inspections, rounding out a seven-year study of abstract problems with concrete results, enabled the engineers to tell the utility companies exactly what power load their systems were capable of carrying with safety and economy without additional equipment. They also determined quickly what additional equipment was required for expansion of the power transmission services.



Adjusting a circuit on the alternating current network calculator



The turn of a dial, the snap of a switch, reproduce in the laboratory a miniature replica of any power system in the world. This instrument that "thinks" for electricity is called an alternating current network calculator.

Westinghouse started the calculator study in 1930 to investigate system problems involving voltage regulation, stability, and loading of electrical equipment.

Like a G-man of electricity, the calculator discovers why, for no obvious reasons, transformers are overloaded and determines means of better controlling the circulation of power. It helped the United States Army engineers study the behavior of various proposed system designs for the generators, motors, and transmission lines for Boulder Dam, Bonneville, and other Federal projects.

The calculator studies have indirectly saved the power consumers of the nation many millions of dollars by enabling the utilities to carry larger loads efficiently, safely, and economically without the expenditure of money on unnecessary extra equipment.

Before the calculator went to work, utilities frequently had to invest in expensive lines and equipment as a safety measure. One company installed 50 miles of transmission line in order to carry an estimated peak load. The calculator later disclosed that the existing line would have carried the load safely.

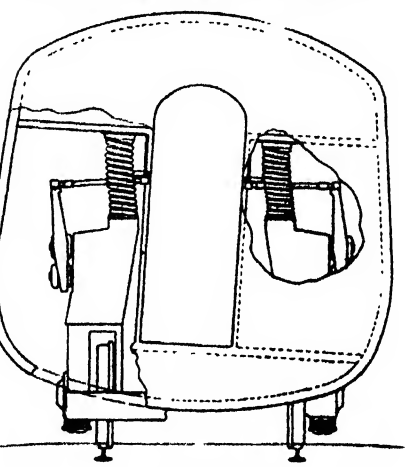
New Surgical Anesthetic

By mixing three parts of ethyl ether and one part of vinyl ether, a volatile surgical anesthetic superior to either alone is being produced. Vinyl ether alone was introduced a few years ago for this purpose but developed defects which are avoided by using such a mixture with the customary ethyl ether.—*D. H. K.*

Spring-Suspended Rail Car

Possibility of adapting aircraft design and production technique to the railroad industry is demonstrated in the development

Full-scale unit (*above*) of a new type of railway car truck in which coil springs and control arms project up into the car body. *Below:* Partial section of a car body shows how the weight is spring suspended



of a new type of railway car of spring-suspended design recently successfully tested. The familiar monocoque, or stressed-skin principle, and construction of full scale Douglas fir plywood models, or mock-ups, were two of the aircraft industry's methods employed.

The experimental two-car train incorporates an ingenious method of body suspension. The car body is suspended on springs and control arms mounted on pedestals, or towers, which rise several feet into the car body from the railroad trucks.

Weight reduction through stressed-skin construction is another feature of the experimental cars. With this method, the entire body—sides, roof and floor—carry the stresses, instead of letting heavy side trusses do all the work, with the superstructure serving merely as weather protection and an added weight burden.

Use of Douglas fir plywood and lumber in the experimental car bodies made it possible to build them with a minimum of equipment and in a much shorter period than if they had been built of metal. The cost was considerably less and there was a degree of flexibility of design which is necessary to a project of this sort. In actual service-trains, the cars would be built of metal. Advantages predicted and already realized in road tests on the plywood models are superior riding comfort, light weight, economy of operation, low first cost, and safety.

Cortland T. Hill, grandson of James J. Hill, the famed "Empire Builder," is sponsor of the project. Directly associated with Mr. Hill are William E. Van Dorn, originator of the project, and Dr. F. C. Lindvall, of the California Institute of Technology. Important contributions to the design and construction of these new cars have been made by Paul K. Beemer, Eliot F. Stoner, and Herbert J. Wieden, aircraft and automotive engineers who have introduced many innovations from those transportation industries. In this experimental work, the Atchison, Topeka and Santa Fe Railway is co-operating in providing motive power and testing facilities.

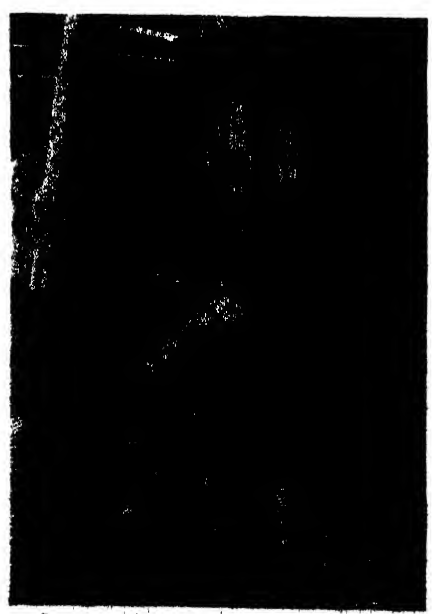
TEMPERATURES

A recent well drilled at Palestine, Texas, 9000 feet deep, showed a bottom temperature of 225 degrees, Fahrenheit. One deep well in the Kettleman Hills region produced 200 degree, Fahrenheit, water at the rate of over 5000 barrels a day—instead of oil.

New Type of Timber Construction

To speed erection of buildings for the 1939 Golden Gate International Exposition on San Francisco Bay, as well as to facilitate dismantling after the 288 days of the Fair, a new type of timber joint was evolved. It is said to be one of the most important developments in heavy frame construction in recent years.

On several of the structures, the majority of the timber joints were constructed with a strap and pin type joint, consisting of a series of steel straps and channels interconnected by means of a pin bolt. The steel straps are connected to the timbers by flush type sheer plates and bolts. The joint is so designed that it can take either tension or



Interconnected steel straps and channels hold timbers together

A 108-foot tower constructed with the new timber joints described

compression. The joint was developed under the direction of John J. Gould, Chief Structural Engineer of the exposition.

In the construction of the 105-foot Triumphal Arch, the main frame was constructed with this new type joint. All framing was prefabricated on the ground, the lower 60 feet of each side of the arch being erected in six hours. All studding and sheathing were assembled in panels and the sections provided with Byrkit lath ready for plastering.

This new type of joint will greatly facilitate dismantling, an important factor in the economy of temporary structures such as the exhibit palaces of an exposition. It is claimed that the new design is also particularly well adapted for the re-erection of framework, thus making possible a maximum of salvage from the exposition.

Why Leap from Frying Pan to Fire?

THE United States has made greater progress in providing medical care for its people under the present system than any country that has abandoned that system, and the nation should, therefore, hesitate to adopt any system that would give less progress toward good health.

That is the American Medical Association's answer to the report of Miss Josephine Roche, head of the Inter-departmental Committee to Co-ordinate Health and Welfare Activities of the United States Government, recently presented to the President. The American Medical Association commented on it in an editorial in the association's *Journal*.

Miss Roche's report, in the opinion of the medical association's editor, says in effect that the answer to the problem of medical care is sickness insurance and federal or other subsidy or both, but the medical association's editor comments that failure of the authors of the report to mention the positive side of present American accomplishments in the field of medicine and health gives their report a dismal tone beyond what the situation warrants. He adds: "Our progress up to now, which is greater than that in any country that has abandoned our system in behalf of some socialized system of medical care, should cause hesitation in rejecting the pattern of progress that has brought such results, in favor of patterns that have been tried elsewhere with far less success."—*Science Service.*

HYDROGENATION

AT the present yearly requirement of one and one half billion barrels of crude oil, the known supply of more than seven quadrillion tons of coal could be converted by hydrogenation and cracking processes into enough oil to supply the world for over 24,000 years.

Controls "Brown Patch" and Colors Grass Green

SCIENTISTS have combined the practical with the esthetic in a new fungicide for the control of brown patch, a disease of lawn and golf grasses. The fungicide not only controls the disease but dyes the grass any desired shade of green.

The United States Golf Association, through its greens workers, co-operated with the Department of Agriculture in the research work, which was under the direction of Dr. John Montieth, Jr.

The scientists found they could match any grass with the proper shade of green by adding about half-and-half of malachite green and auramine O, a yellow dye, together with about 2 percent of crystal violet, a red dye. This mixture is just as effective as a fungicide as the original dye.

A half ounce of the mixture, costing about 10 cents, diluted with two to five gallons of water is sufficient to spray 1000 square feet of turf.

The fungicide keeps the grass green from three days to three weeks, depending on the weather. A rain before the fungicide has time to dry washes it off quickly. Too, the color will not stand up as long in hot summer weather as in the winter.

Greens keepers on golf courses have used the fungicide and found that it does not harm healthy grass, and improves both the color of uneven greens and the tempers of crochety members who blame their poor putting on the uneven color of the putting greens. It also has been used on football gridirons and baseball infields.

The fungicide may be applied with an ordinary knapsack spray, or larger equipment if available.

Whey

A MULTITUDE of uses have been found for whey, formerly milk's equivalent of the famous pig's squeal that couldn't be set to work. Sweetened and dried, whey, a by-product of cheese manufacturing, makes an excellent candy filling. "Whipped cream" can be made from whey. Flavor and food value of canned or home-made soup is improved by the addition of powdered or condensed whey. Tomato juice and fresh whey, when mixed, form an "attractive" beverage or starting point for a variety of tomato soup.

This is the essence of a report by B. H. Webb of the United States Bureau of Dairy Industry before the Food Technology Con-

ference at the Massachusetts Institute of Technology.

"The high nutritive value of whey has prompted the Bureau of Dairy Industry to investigate its use in food for man," Mr. Webb declared. "Whey contains most of the minerals, lactose, and soluble protein of milk." Previously, he explained, small amounts had been used as stock food, only a "very small portion being utilized as human food."

Use of sweetened whey or whey powder allows jam to be whipped to double its volume, Mr. Webb also reported. Canned fruit whips were another food listed by the speaker which whey improves.—*Science Service.*

EARTH STEAM

IN Italy, steam from the earth is used to generate 19,000 horsepower daily. Volcanic steam is used in Sonoma County, California, to generate electricity. Other places not yet developed are: the Valley of Ten Thousand Smokes, Alaska; Lassen Peak in California; Steamboat Springs, near Reno, Nevada; and the Yellowstone Geyser region.

Accordion-Folded Aluminum Insulation

A NEW type of house insulation—so light in weight that 80 pounds of it is sufficient to insulate more than 1000 square feet of roof or walls, and so easy to apply that the only tools required are a pair of shears, a hammer, and tacks—is called Air-Met. The insulating efficiency of the new product is based to a large extent upon the application of the heat-reflective value of aluminum foil, according to an announcement by The Ruberoid Company. Outstanding advantages claimed, in addition to high thermal efficiency, light weight, and ease of application, are easy portability, imperviousness to moisture and vermin, long life, and elimination of dirt and inconvenience.

The new product consists, primarily, of two thin, parallel sheets of aluminum foil, definitely spaced about an inch apart by a series of triangular air cells of uniform size. Between the two sheets of foil is a light, flame-proof member which, by reason of its truss like design, serves the double purpose of holding the foil sheets parallel and insuring perfect uniformity in the size and spacing of the intervening air cells. When properly installed, provision is also made for air space between the outer surfaces of the two sheets of foil and the surrounding studs, rafters, sheating, wallboard or protective paper.

The lightness of the material and its convenience for handling is indicated by the fact that enough Air-Met to insulate the average attic, 1000 square feet, is contained in two small cartons, each measuring 8 by 18 by 31 inches.

The material is manufactured in two widths, 15 inches and 23 inches, representing the standard distances between studs, joists, and rafters. It comes in sheets about 80 feet long which, when packed for shipment, are folded together lengthwise like an accordion. For installing, these sheets are simply spread by hand, also as an accordion would be extended.

Elastic Metal

THE ability to combine steel and rubber into one material is an important discovery in the science of producing artificial working materials. This German "elastic metal," which is composed of a mixture of steel and soft india-rubber, is said to be an excellent material from which to manufacture springs of all kinds, as well as couplings in machinery. This composition can also be used to advantage for sound-absorbing devices.

Read Paper by Two Billion Candlepower Light at 27 Miles

HOW far can one read a newspaper by the light of the world's most powerful light? A group of technicians sought the answer to this question recently, when the 2,000,000,000 candlepower beacon atop the Colgate-Palmolive-Peet Building in Chicago was turned into the world's largest reading lamp for 90 minutes.

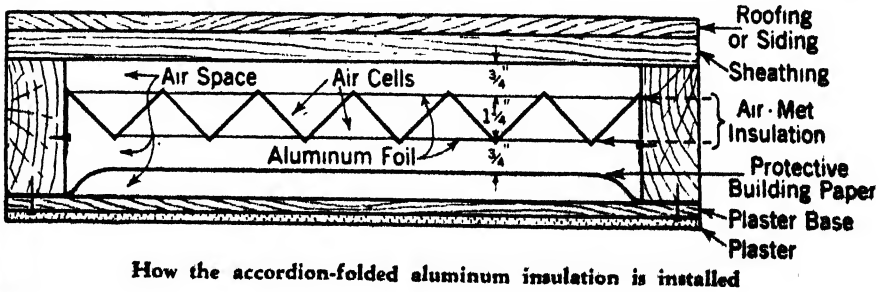
Flying at 7000 feet over Chicago, passengers on board a special United Air Lines' *Mainliner* were able to read a newspaper by the light of the huge airway beacon at a distance of 27 miles.

At one yard from its source, this beacon, the world's most powerful light, is 20,000 times brighter than the noon sunlight at the earth's surface and eight billion times as bright as the full moon.

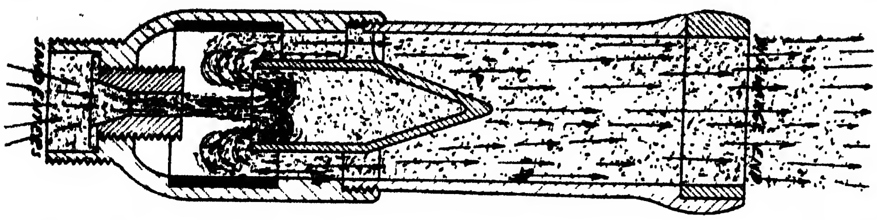
Sand Blast Gun Has Flat-Mouthed Orifice

A NEW sand blast gun, being manufactured by Michiana Products Corporation, incorporates features of design and principle said to provide better surfaces for painting and finishing wood and steel rapidly and without injury to the surfaces of the materials.

This gun, as the accompanying sketch shows, has a chamber in which the sand meets a baffle which sets up a whirling motion, reducing the sand particles and in-



How the accordion-folded aluminum insulation is installed



***Above:* Cross-section of the orifice of the sand-blast gun that is shown below cleaning a sheet-steel surface**

creasing the number of cutting edges. Sand is delivered under pressure through a flattened orifice fitted with abrasive-resistant alloy steel lips. The result is a flat stream of sand expelled under uniform pressure. It is claimed that this design permits the use of lower cost sand, removes grime, grease, and old finishes faster, and reduces buckling to a minimum on light materials, without cutting or pitting the surfaces.

Wine in Tank Cars

A NEW type of phenol-aldehyde resin (Bakelite) has been developed which will serve as a coating for lining tank cars and similar steel containers to make them so resistant to chemical corrosion that wine can be carried in them without altering its flavor. The coating of tin cans for beer and wine with resins has become accepted practice but the application of resinous linings to tank cars and tank steamers, which do not have an initial tin lining, represents a substantial advance.—*D. H. K.*

Common Sense Versus Sentimentality

ACQUITTING criminals because of a mental disease or semi-mental disease is often but a release of wolves to prey on the people. It should no longer be tolerated. Dr. Foster Kennedy, New York psychiatrist, makes the foregoing statement in discussing the psychiatrist's responsibility to the criminally insane and to society in the *Journal of the American Medical Association.*

Dr. Kennedy recommends the following program as one for ardent hope:

1. That in all cases of felony or misdemeanor punishable by prison sentence, the question of responsibility be not submitted to the jury. The jury should be called on to determine only that the offense was committed by the defendant.

2. That the disposition and treatment (including punishment) be based on a study of the individual offender by properly qualified and impartial experts co-operating with the courts.

3. That no maximum term be set to any sentence.

4. That no parole or probation be granted without suitable psychiatric examination.

5. That in considering applications for pardons and commutation, careful attention be given to reports of qualified experts.

6. That there be chosen a panel of qualified medical opinion, if possible from university and major hospital staffs, who would advise the conscience of the court. These physicians would receive adequate remuneration from no private individual or corporation but from the state only.

As a community, thinks Dr. Kennedy, we are too jealous of the life of the killer and not thoughtful enough of the life that has been ended.—*Science Service.*

Amateur Seismology

A MORE thorough investigation of earthquakes, especially in the western mountain region of the United States, is urged by Dr. N. H. Heck, of the United States Coast and Geodetic Survey, an authority on seismology and on the earthquake history of the United States. He mentions the importance of data supplied by amateur observers. "The growing interest in amateur seismology," he writes, "gives promise of information from simple instruments which will supplement that from other sources. Not only will better estimates of intensity and epicenter be possible, but there will be developed a corps of observers who can better describe their experiences during an earthquake."

By-Product Utilization

MANUFACTURE of lard-like fats by the hydrogenation of fatty oils is being undertaken by the Hooker Electrochemical Company, manufacturer of caustic soda and chlorine by electrolysis, to utilize the by-product hydrogen from their principal operation. This plant, being erected in Tacoma, Washington, emphasizes the remote fields into which the by-products of apparently simple chemical processes frequently lead.—*D. H. K.*

Why Do Stranded Whales Die?

WHALES are mammals, not fishes, and they breathe oxygen direct from the air only. They cannot breathe the oxygen dissolved in water, as do the fishes. That being the case, why is it that whales so soon die when washed ashore?

The answer: Probably nobody positively

knows. In *Nature* (London), however, appears a communication from W. A. Osborne of the University of Melbourne, Australia, stating several hypotheses:

"When a school of whales was stranded on an Australian coast, much to the discomfiture of local health authorities, I put to various colleagues in the University of Melbourne the simple query: Why do stranded whales die? I received the following answers, and it was amusing to note that in most instances the explanation was colored by the special study of the colleague interrogated.

"(1) The blood now being acted on by gravity collects in the dependent parts and produces anemia of the brain.

"(2) The weight of the body impedes breathing.

"(3) Vital organs are crushed by the great weight.

"(4) The unaccustomed warmth, especially if there is direct insolation, induces heat stroke.

"(5) The unaccustomed temperature interval between night and day gives rise to internal chills and probably pneumonia.

"(6) The whales do not die because they are stranded; they are stranded because they are dying.

"Perhaps the list can be extended by readers of *Nature*."

Perhaps, too, the same list can be extended by readers of Scientific American, though the list as given seems already to contain some weighty and adequate reasons.

Ethylene Treatment of Tobacco

ETHYLENE, now widely applied for treating citrus fruits, English walnuts, and other fruits to induce ripening, has a beneficial effect on the curing of leaf tobacco. The treatment matures the leaves, improves the flavor and aroma of the tobacco, and reduces the curing period by as much as 40 percent. Investigations of the commercial application of this new treatment are being conducted by the British Colonial Office.—*D. H. K.*

Mica Pellets for Insulation

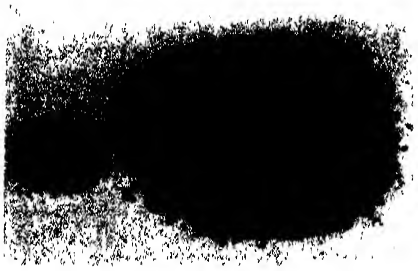
AN extraordinary property has been discovered in little flakes of a type of mica called vermiculite. Upon heating, these tiny flakes act somewhat like popcorn, expanding to about 16 times their original volume and giving a resulting pellet which resembles a miniature accordion. After considerable research, F. E. Schundler and Company, Inc. have developed many uses for these expanded mica pellets, for they are fire-proof, vermin-proof, moisture-proof, are free pouring, harmless to handle, have high dielectric strength, are chemically inert, and are as everlasting as stone.

The varieties of this mica which contain as much as 20 percent of water are heated by passing through huge Schundler furnaces at a temperature of 2000 degrees, Fahrenheit. The water turns to steam and expands each pellet in a direction at right angles to the planes of cleavage. The terrific heat—sufficient to melt steel—transforms the color from black or dark brown to a silvery or golden hue. The raw material

weighs about 100 pounds per cubic foot while the expanded pellets weigh only about six pounds per cubic foot.

These pellets are being used as insulating material in refrigerators, ovens, fireless cookers, incubators, as pipe and boiler coverings, in the hollow spaces over ceilings, and between walls of houses.

Insulating plasters, fireproof insulating boards, roofing slabs, insulating cements,



Vermiculite mica (*left*) and an equivalent quantity after expansion into pellets for insulation uses

insulating bricks, combustion chambers, refractory bricks, and acoustical tiles and plasters are some of the products which are made with the Schundler mica pellets as the base. The golden color of the mica pellets is utilized in making gold paint. The material may also be used as a pigment of calsomine by tinting to the desired color. Mica pellets are also used as a decorative material in wall papers.

New Resins

Sulfur dioxide and the olefins produced as by-products in the cracking of petroleum react in the presence of catalysts or in light of certain characteristic wavelengths to form valuable resins. The two gases are mixed with a catalyst in a sealed container at low temperature; on allowing the vessel to warm up, reaction occurs yielding easily molded resins of valuable characteristics. Catalysts used consist principally of oxidizing agents, such as nitrates and organic peroxides. The resins themselves are easily molded and may be colorless and transparent. They are thermoplastic (softening on heating), and both hard or rubbery resins have been prepared.—*D. H. K.*

Thunderless Lightning

Contrary to general belief, every lightning flash is not accompanied by a clap of thunder, according to K. B. McEachron, General Electric engineer in charge of high voltage and artificial lightning phenomena. His investigations have proved that there are often lightning strokes which produce little or no thunder at all. Such flashes may appear just as bright as others, but their destructive force is less.

"Thunder is the result of a pressure wave caused by the sudden expansion of air created by a quick lightning discharge," Mr. McEachron says. "All flashes do not release energy with the same speed. Our studios during the past three years have revealed that in some cases the electrical current is built up and released slowly; that is, in one or two tenths of a second as compared to millionths of a second in other discharges. This so-called slow lightning produces no thunder. To the human eye it looks the same, and during a general storm the fact that

one has heard no thunder in connection with any given stroke is generally overlooked.

"People have the conception that lightning moves very swiftly, and this conception is true, but the rate at which the current builds up once the path is established may be relatively small, thus giving rise to the phenomenon of lightning without audible thunder. The strokes of lightning which are most destructive, and do the most damage from the point of view of damage to trees or other objects which may be struck, are of a type in which the current builds up very rapidly, not in terms of a fractional part of a second, but in terms of millionths of a second, and this very rapid rise of current produces a correspondingly rapid rate of pressure rise in the air, which transmitted to the ear gives the sound of thunder."

Mr. McEachron also declares that most thunder does not reach one's ears as a single crack because sound travels at the rate of approximately 1100 feet per second, and one portion of a lightning discharge in the clouds may be six seconds away from the earth; whereas that portion of the discharge near the earth may be only one second away. Then, too, Mr. McEachron points out, his investigations have shown that there are often multiple discharges appearing as a single stroke, in which as many as 40 discharges have been recorded in one second of time.

This type of lightning gives rise to a ripping or tearing sound because of the rapid succession of discharges, each producing sound waves which reach one's ears at different intervals. Added to this there is the reflection of sound from clouds, hills, and buildings, all tending to increase the echo effect.

GOATS AND PIGS

DOMESTIC goats and pigs gone wild are such pests in Hawaii that, to prevent their destructive feeding on native plant life, tight fences are necessary in some places and it may be necessary to encourage wholesale shooting of both animals.

Cadmus of Alphabet Fame Believed Myth

PHOENICIAN Cadmus, popular hero credited with fathering our alphabet, never existed, so far as archeologists can learn. We should honor some unknown Phoenician for teaching the Greeks the ABC's; and the alphabet idea is older than Phoenicians, anyway.

Reporting the latest views on the still-mysterious alphabet, Dr. John Day of Barnard College told the Archeological Institute of America that the Greeks probably derived the alphabet from Phoenicians about the middle of the 9th Century B.C. Dr. Day succeeded in narrowing down the date by demonstrating from old inscriptions that five of the Greek letters could not have evolved later than the 9th Century B.C., and five other Greek letters could not have evolved earlier.

Questioning the recent assertion by "an eminent authority," that Cadmus lived about 1400 B.C., Dr. Day pointed out that when

archeologists dug at the citadel of Thebes, Greek town supposedly founded by Cadmus, they found no trace of Phoenician relics or Phoenician writings.

"We must conclude," he declared, "that the only definite historical element contained in the legend concerning the letters of Cadmus is the fact of the Phoenician origin of the Greek alphabet."

Phoenicians are no longer credited with inventing the alphabet outright, discoveries of old inscriptions having revealed that our alphabet is derived from the Roman, which came from the Greek, which borrowed from the Phoenician, which evolved from letter forms either in Syria to the north or Sinai to the south. —*Science Service.*

Air Turbine Hand Grinder

HIGH pressure air operates a light weight grinder which is claimed to have exceptional power for fast, heavy-duty grinding. This new air turbine grinder, developed by the Onsrud Machine Works, Inc., has a speed of 50,000 revolutions per minute and

Driven by air

is powered by a ¼-horsepower motor. The grinder unit may be practically concealed in the palm of the worker's hand. Air pressure of 90 to 100 pounds is necessary to operate the air turbine and the air consumption is 8 cubic feet of free air per minute upwards, depending upon the model. Cooling action of the expanded air enables the unit to run continuously at less than room temperature, a feature seldom possible with electrically-operated tools of this sort.

This hand tool is useful in die making, internal grinding, drilling, engraving, and many other operations where high power, vibrationless speed, and light weight are important.

Petroleum, Source of Feminine Pulchritude

THE women of America, regarded as the most beautiful of all nations, owe much of their charm to petroleum. No other single product contributes so greatly to feminine beauty as does oil.

The American Petroleum Institute reports that many of the haunting, alluring perfumes which modern femininity uses to appeal to the olfactory sense, are made with solvents and essences derived from petroleum sources. Woman's hair, her "crowning beauty," is waved and set by the aid of petroleum products. Even the nail lacquer, so bright and gay, may be made with petroleum solvents.

The soft, smooth glow on the skin of the modern woman's cheeks and hands were put there by Nature—via petroleum. Most of the pomades, facial creams, and other beauty preparations have highly refined petroleum oils as their base; oils created by nature millions of years ago, aged by mother earth, and brought forth by the petroleum industry.

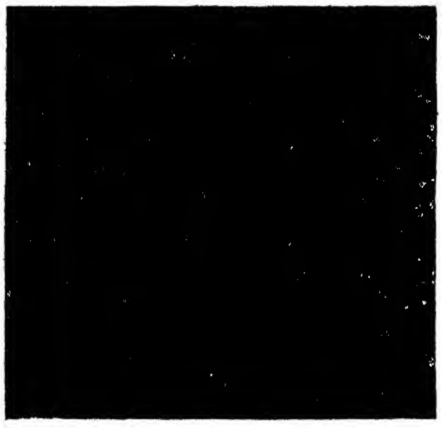
CAMERA ANGLES

Conducted by JACOB DESCHIN

The Wide-Angle Lens

WHAT'S the use of a wide-angle lens? Ask the man who owns one—the commercial photographer, the news cameraman, the just plain you-and-us chap in search of unusual effects even at the cost of distorted perspective.

Before we go into the use of the wide-angle lens, however, let us see exactly what we mean by the term and in what way it differs from the lens normally employed. We know that the "normal" focal length for a given size negative area is the diagonal measurement of that area. For example, a 3¼ by 4¼ inch film ordinarily calls for a lens having a focal length of 5¼ inches, while a 4 by 5 film, the size usually employed by news cameramen, should have a lens of about 6½ inches focal length. By this rule, therefore, if we were to use the 5¼-



A wide-angle "what is it?"

inch lens on the 4 by 5 camera, it would no longer be a "normal" lens; it would be relatively "short" for this camera, that is, it would be brought closer to the film plane and therefore include a greater area than the normal, provided it were so made as to give satisfactory definition over the larger area. Conversely, while we are at it, the 6½-inch lens employed on the 3¼ by 4¼ camera would be "long" for the latter; that is, the lens would be removed farther from the film plane than the normal lens and therefore include a lesser area than the latter.

In general terms, this is the whole story on the nature of the wide-angle or so-called "short-focus" lens. In addition, it must be added that the wide-angle lens is characterized by a relatively greater depth of field, because of its short focal length, at any given distance from the subject; the subject may be approached closely enough to produce so-called photomacrographs or for the merely utilitarian purpose of copying small ob-

Wide-angle foreshortening

jects. Such a lens is ordinarily supplied with small maximum apertures to assure full coverage of the negative area without introducing distortion at the corners.

The commercial photographer uses the wide-angle lens in order to cope with "tight" assignments, such as the photography of small interiors and of buildings at close range, as well as for copy work; the newsman makes the "short" lens his normal equipment because his work generally involves surmounting space difficulties; it also permits him a wider guessing range for focusing on those frequent occasions when there is no time to use the ground glass.

An example of a tight-place situation that was overcome through the use of a wide-angle lens is shown in the illustration of the coin dealer behind his grating. The lobby just outside the grating was very small and would have created quite a difficulty for the photographer, who had to include as much of the grating as possible, had he not been ready for the emergency and had he tried to use a normal instead of a wide-angle lens.

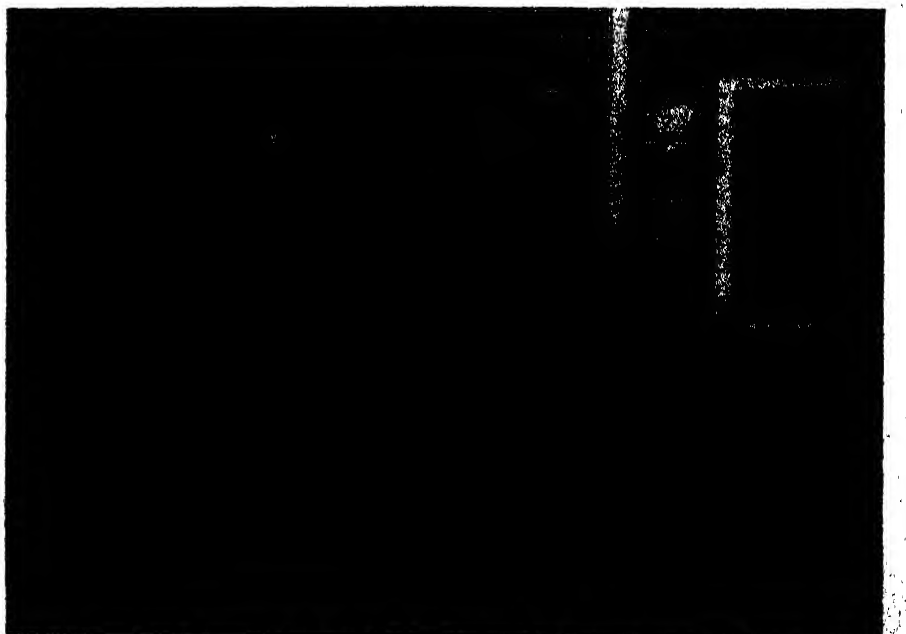
The close-up of the much-highlighted subject, actually the surface of a sheet of sandpaper taken at extremely close range with the light shooting from one side to show texture and bright highlights, is an example of the kind of thing that is often attempted with the short focus lens.

In pictorial photography, the foreshortening effect possible with the wide-angle lens is employed to good advantage in such subjects as that of the park walk illustrating this article. Reverting again to the extreme depth of field characteristic of the wide-angle lens, it may be mentioned that this particular shot was made from the hand with the lens stopped down only to F:11 and with an exposure of 1/25th second. Notice the satisfactory sharpness that prevails from the nearest to the farthest distance, with the exception of the narrow strip nearest the lens.

While it is not advisable to follow the procedure of the news cameramen in employing a short focus lens as normal equipment, the advantages and usefulness of having such a lens "on tap" for the out-of-the-ordinary occasions are self-evident.

Theme Competition

HERE is a second opportunity for the readers of this department to win prizes by competing in a fascinating phase of the art of photography. Each month there is given a definite assignment in interpretive photography, to be fulfilled according to each individual photographer's own imagination or artistic ability. Prints submitted in these monthly competitions will be judged on the interpretation of a theme, as well as

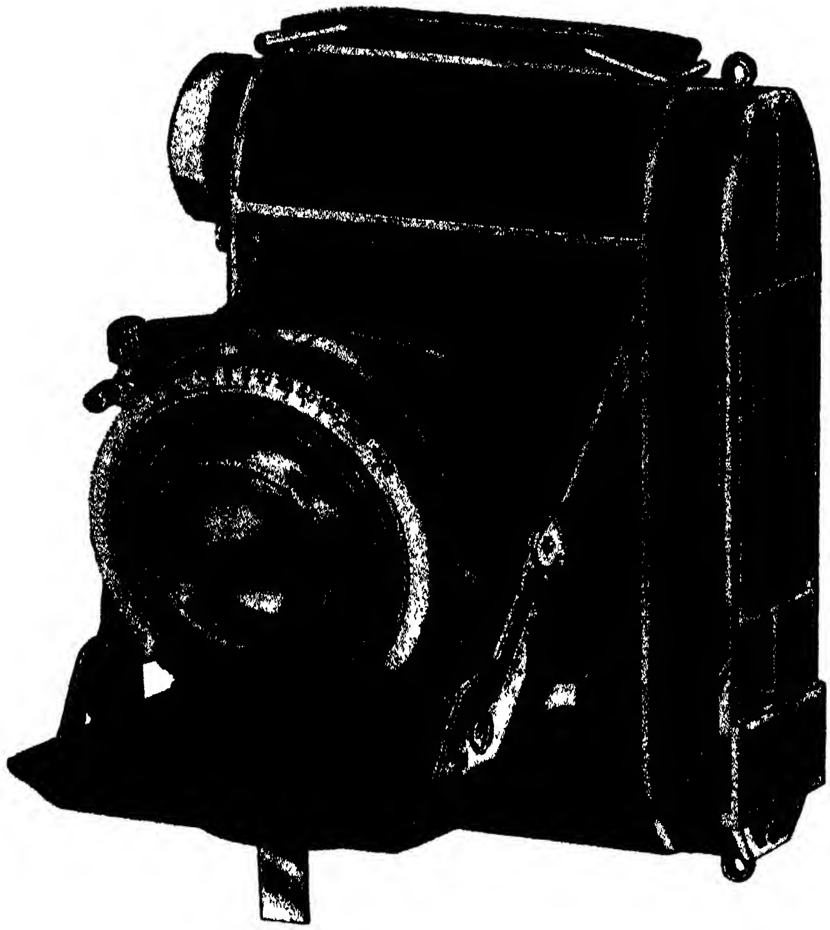


Taken in close quarters with a wide-angle lens

Check these four big

BALDAXETTE

features



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on pictorial appeal and technical excellence. Each month two cash prizes—$10 for the first prize and $5 for second prize—will be awarded, and there will be two honorable mentions, each to be a year's new or extension subscription to Scientific American.

The simple rules of the contest are as follows: (1) All prints submitted must be mounted, the over-all size *of the mounting* not to exceed 11 by 14 inches. Prints may be any size from 3¼ by 4¼ inches up to the maximum area of the mount. (2) Not more than one print may be submitted by each contestant, it being left up to him to judge his own work, and to select the one which, in his opinion, best portrays the theme of the assignment. (3) Prints may be forwarded by any means desired but each must be accompanied by the required return postage. (4) No names or titles are to be placed on the face of the photograph; on the back of the mounting must be given the contestant's name and address, together with the name of the camera and of the film employed. (5) The competition will be judged by the conductor of this column and the editorial staff of Scientific American. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants. Prize-winning photographs will become the property of Scientific American to be used in any manner at the discretion of the publisher. (6) No entries will be considered from professional photographers. (7) Prints may be black-and-white or toned; no color prints will be considered. (8) All entries in the second Scientific American Theme Competition (May, 1938) must be in the hands of the judges by June 1, 1938. The results will be announced in our issue dated August 1938. (9) This competition is open to all amateur photographers who are not in the employ of Scientific American.

MAY COMPETITION THEME: "HAPPINESS"

The assignment for the second competition is "Happiness." In this case, the interpretation of the theme might involve the arrival of a check by mail, a group of children playing, a scene on lovers' lane, a workman at his chosen task, and so on to the limit of your resourcefulness. These hints are thrown out at random and are not necessarily to be considered as definite suggestions.

Address all entries: "Happiness" Competition, Photograph Editor, Scientific American, 24 West 40th Street, New York, N. Y.

Here is something well worth shooting at, both to test your sense of photographic interpretation in competition with others, and because of the prizes involved. Go to it!

Watch for the third assignment next month.

Latitude of Kodabrom

THE latitude of the new Eastman Kodabrom enlarging paper was illustrated in a panel at the recent Kodak International Exhibit for 1938. The exhibit included more than 200 photographs on varied subjects selected from about 1000 submitted by amateur photographers in 19 countries.

The Kodabrom panel displayed six enlargements made from the same negative, and although the time of exposure in making the enlargement and the duration of the developing time was varied in each case, all six prints were identical in result. All six

enlargements were developed in D-72 of the same strength, with the exposure and developing time (in seconds) varied as follows:

	Exposure	Developing Time
Print No. 1	7	120
Print No. 2	10	90
Print No. 3	14	60
Print No. 4	18	40
Print No. 5	23	35
Print No. 6	30	30

Flower Photography

INDOOR flower photography by artificial light makes a pleasant indoor exercise when "housebound" for one reason or another. While the lighting of a flower subject is not the easiest thing in the world (nor is the arrangement, for that matter), the

"Daffodil"

way can be made much easier by the realization that the two principal features to look for are the display of texture and the representation of the flower's form. "Daffodil," for example, does, we believe, fulfill these two requirements, for the texture of the flower is revealed by light passing through the petals, and form is revealed by a suitable disposition of light and shadow. Two lights were used, one coming from the side, the other (a weaker light) from the top.

Filing Prints

YOU can take it or leave it, of course, but here's an idea that may help somebody. You are familiar with the "expanding" envelopes that constitute a sort of portable filing case. These may be had in different styles of heavy material and in different colors, but this feature is immaterial. The point is: The pockets are separated one from another and each one is tabbed A to Z, 1 to 31, or whatever. That does not matter either. Sort your pictures out according to subjects, paste labels over the tabs, print in the name of the subject, such as Landscapes, Baby Portraits, and so on, and store your prints under the various headings.

Film Kink for Leica Fans

IF ever you are obliged to use in a Leica camera the Contax "daylight loading" type spool, which is furnished with a perforated paper trailer at each end, here is the way to do it: attach the end of the paper trailer to the Leica take-up spool and insert

take-up and Contax spools in the usual manner of loading film, making sure, as under normal circumstances, that the perforations engage the sprockets. Close the cover and start turning the winding key, clicking off 14 or 15 "exposures." This will unwind the paper completely as well as two or three film sections for the usual precaution, bringing your first film section into place. When the complete roll has been exposed, it is not necessary to rewind into the original Contax spool; continue winding until the take-up winding knob no longer revolves. This will indicate that the paper trailer at the other end has been wound off the spool onto the take-up spool and you are ready to uncover the camera and remove the spool for development.

What's New
In Photographic Equipment

Model C Argus

ENCOURAGED by the phenomenal success of the inexpensive Argus 35-mm camera, the manufacturers have now brought out a new model which, though costing double the price of the original Argus, incorporates many remarkable features for a camera of such low price. The new Argus ($25.00) includes the following: A built-in range finder of the split image, sextant type; a speedier lens—F:3.5 Cintar anastigmat; shutter speeds from 1/5th of a second to 1/300th; optical glass view finder; mount providing for quick interchange of lenses; film winder with automatic exposure counter. A complete line of accessories is available for this camera.

Pyrex Graduate

KITCHEN technique has invaded the photographic darkroom with the introduction by Willoughby's of the new 32-ounce Pyrex graduate ($1.00) for photographic use. This graduate has the advantage of permanent red graduations fused into the glass, facilitating easy reading. Its features include resistance to breakage from hot or cold liquids, no sharp edges, smooth inside and outside, wide top opening for easy cleaning and convenient stirring.

Agfa Film Loadings

TWO new Agfa film loadings have recently been made available, according to an announcement by the Agfa Ansco Corporation. One is the 30-exposure spool ($1.00) especially designed for the Robot camera and carrying duplex paper leaders and trailers. This is available only in Agfa Superpan. The other film is Agfa Hypan Reversible motion picture film, which is now made available on special order in 50-foot cassettes ($3.50) for the Siemens Halske 16-mm movie camera.

Falcon Cameras

CHARACTERIZED as "a camera that is so simple to operate that no special knowledge is required, no complications to master," the miniature model Falcon camera ($3.98) has recently appeared on the market.

Also included in the Falcon line of Amer-

ican-made cameras is the candid camera model, equipped with the Wollensak F:3.5 lens ($21.50) or F:4.5 ($17.50), as desired, and taking standard Kodak 127 or Agfa A8 film to turn out 16 pictures to the roll. The camera has a built-in "spyglass" view finder, the case is of Neilite in ebony black, and all exposed metal fittings are attractively finished in brush satin chrome.

Enlarger with Interchangeable Lenses

EXTREME ease of operation and unlimited scope, the latter due to the easy interchangeability of lenses, is claimed for the Exakt enlarger, an importation of Henry Herbert, of New York City. The Exakt is said to have all the conveniences of an automatic enlarger with the added attraction of an additional hairline adjustment that assures critical focusing.

Several models of the Exakt enlarger are available ($55.00 to $290.00), some with one lens and others with two or three, thus making it possible for the photographer to adapt his enlarger to the exact requirements of the job in hand.

Negative Viewer

THE Mico Negative Viewer and Marker for 35-mm. negatives is announced by Mimosa American Corporation, priced at $6.50. The negatives are viewed greatly enlarged, permitting comfortable examination of 35-mm. negative strips in the preliminary routine of determining which negatives are to be enlarged and which are to be ignored. Negatives selected for enlargement are nicked with a notching punch for later identification. For even illumination over the entire magnified field an adjustable light diffuser (75 cents) is available for attachment to the viewer.

The Dakko Enlarger

INCORPORATING many unusual features, the American-made Dakko enlarger is creating a widespread interest. Handsomely designed and easily manipulated, the Dakko ($69.50) is featured by a microscope-type elevator for quick adjustment of the height of the lamp housing; a micro-vernier adjustment is provided within the hood for perfect instantaneous focus. An intense and clear field of white light is assured by a small GE bulb, in combination with a diffusing lens. The bulb, 100-watt, has a life of 50 hours and is readily replaceable.

Another feature of the Dakko is the fact that the housing may be swung to stay in position at any point within an arc of 360 degrees, making it useful for enlarging to any size, up to photomurals. Ventilation is provided in the housing by an aero-syphon ventilator, which sprays the bulb with a constant stream of cool air. This syphon is equipped with heat dissipating fins.

Two methods of accommodating the lens are provided in the Dakko. One is an 18-

leaf metal diaphragm, perfectly light-tight and accepting any lens from ¾ to 3 inches in diameter without injury to the thread. Also, a lens plate is provided taking the regular Leica lens or capable of being adapted to receive the Wollensak lens, which is optional equipment with the Dakko.

A variable opening mask, finished in optical black and felt stripped to prevent any scratching in the negative, permits the use of negatives from the standard 35 mm up to 2¼ by 3¼ inches. A wing on the side of the housing holds the negative roll.

The Dakko has a 16 by 20-inch easel. This new enlarging camera, by means of a few simple adjustments, may also be employed as a copying camera to copy pictures, tracings, and so on.

PHOTOFLASH

THE new Mazda Photoflash No. 7 will appeal to those news and amateur photographers who desire a longer flash and minimum bulb size. The small bulb is filled with finely-drawn aluminum wire and also contains a small piece of aluminum foil. The flash is so timed as to require no change in synchronizers adjusted for Mazda Photoflash Lamp No. 20. Its relatively long duration of flash will be welcomed also by users of curtain shutter types of miniature cameras, particularly for properly synchronized, high-speed shots.

THE AGFA CLIPPER

EXTREMELY inexpensive, simple in operation and compact in design, the Agfa PD16 Clipper camera ($5.00) is receiving serious consideration from would-be amateur photographers who want to "feel their way" in photography before venturing the higher outlay demanded by the general run of modern miniature cameras.

The Clipper is made of pressed steel and features a new "pull-out" front. The camera uses PD16 film (same as 616), taking 2⅛ by 2½-inch pictures. The lens is a new type universal focus ("Unifo") model, while the shutter is the self-capping type giving both instantaneous or bulb exposures. Other features: hinged back and film spool guides that simplify the loading operation, and a built-in shutter release guard that prevents exposures from being made when the camera front is in closed position. The Clipper is finished with a grained black covering that is waterproof; exposed metal surfaces are finished in nickel and black enamel. Available accessories include color filter, portrait attachment, and leather carrying case.

COMPLETE RETOUCHING SET

PURCHASING an outfit complete saves a fellow a lot of headaches. Usually he can buy the complete outfit more cheaply as a "piece" than if he were to purchase the individual items separately. Also, items are included which he would not have thought of purchasing but which prove mighty handy nevertheless. The Trojan Retouching Outfit, distributed by the Central

Camera Company, and priced at $3.00, is an example of what we mean.

"With the help of this new set," the distributors claim, "any picture can be improved and salon prints can be produced from apparently hopeless negatives."

An instruction book explaining the technique accompanies the set, which includes: 3 drawing pencils; 1 dram of Mercurochrome intensifier; ½ ounce of alcohol; ½ ounce of spirits of turpentine; 3 artists' brushes (No. 00, No. 1 and No. 3); one 6-inch metal-edged ruler; ½ ounce ammonia; ½ ounce pumice; ½ ounce varnish; 1 etching knife; 1 dram India ink; 1 dram white ink; 1 dram sepia ink; 1 art gum; 1 pencil eraser; 1 stump pencil. The outfit is packed in a metal box with a built-in mixing palette, the shipping weight being 5 pounds.

FEDERAL ENLARGER

SINCE the process of enlarging miniature negatives has become practically as essential as the actual picture-taking itself, it is natural that some manufacturers are giving their closest attention to the perfection of enlargers for amateur use.

Advance announcement has been made by the Federal Stamping & Engineering Company of the introduction of their new Model No. 120 Photo Enlarger ($17.95). Among its many features is found the fact that it will take negatives from miniatures up to 2¼ by 3¼ inches. It has a Raynar 3-inch Anastigmat lens and will make enlargements up to seven times, linear. Other features include: an efficient and well ventilated illuminating system; calibrated easel; 16- by 18-inch baseboard; hinged type border maker and paper holder attached to baseboard bracket; four negative masks; 125-watt projector lamp; double diffusing plates for intensified illumination; built-in diaphragm with red filter; approved type control switch, cord, and plug.

DARKROOM KIT

INTRODUCED as a suitable developing and printing outfit "for every beginning amateur who wants an outfit that will serve as the nucleus of his darkroom equipment," the Agfa Darkroom Outfit No. 2 ($4.95) has been made available by the Agfa Ansco Corporation. The outfit includes three 5 by 7 steel trays covered with white acid-resisting enamel, a stainless-steel tray thermometer, two stainless-steel film clips, an 8-ounce glass graduate, one glass stirring rod, one 4 by 6 inch printing frame, a six-watt selenium safelight bulb, five M-Q developer tubes, ½ gallon size container of acid hypo and an instruction book.

YOUR QUESTIONS ANSWERED
A Service for Amateur Photographers
See Next Page

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. **Is there any way of avoiding the labor of making test strips in enlarging? Could not some density meter measure negatives for exposure beforehand?—S. E. L.**

A. In the miniature field the Cargille Negative Integrator offers a generally accurate guide to printing exposure, while for these and other negatives, the Dremmeter Print Exposure Gauge has been found eminently suitable.

Q. **Is it true that the larger the dimensions of the negative employed, the more critical becomes the factor of exposure? Little inequalities of lighting in small negatives are not so apparent, but in large negatives become glaring defects. In other words, does the larger camera require more skill in this respect than does the small one?—L. E. S.**

A. Poor lighting is poor lighting, no matter what the size of the negative; a poor exposure in either case is to be avoided as much as possible. Suitable lighting and adequate exposure are the essentials of all good negatives, whether 35 mm or 8 by 10.

Q. **What is the longest telephoto lens one can use for hand-held exposures, without magnification shake in the negative?—J. K.**

A. Telephoto lenses of moderate focal length are often used in the hand without any trouble in this regard, although, generally speaking, it is best not to hazard a shutter speed slower than 1/100th of a second. In the main, the use of telephoto lenses in hand-held exposures depends on the ability of the individual to hold the camera steady during the exposure interval. When using lenses of extreme focal length it would seem the better part of wisdom to mount the camera—or lens mount—on some steady support.

Q. **I find that the principal drawback in using the ferrotype process of drying glossy prints is the long delay in drying. Can you recommend a faster method than merely setting up the tins against a wall in a warm room?—E. C.**

A. An inexpensive electrically heated device similar in general principle to those used by professional photo finishers is available. Another method is to use the Quik-Heat electric fan, which dries glossy prints and makes them drop off the tins within 15 to 20 minutes when the fan is placed at a distance of about three feet from the tins. One amateur finds that he gets satisfactory results by holding the tin in suspension over a lighted gas ring. In any case, the best results are obtainable by thorough squeegeeing through a photographic blotter which absorbs a lot of the moisture and leaves the prints lying absolutely flat against the tin.

Q. **I use D-72 developer in enlarging on bromide papers and make up a quart each time I mix a new supply of stock solution. I understand that in order to prevent oxidation of the developer it is necessary to fill the bottle to the top. Can you suggest a method of storing a quart of stock solution so that this danger of oxidation may be avoided after some of the developer has been used up?—C. S.**

A. D-72 is mixed 1 to 4 in bromide work, as you know. A good working solution is about 40 ounces for 8 by 10 or 11 by 14 enlargements. For smaller enlargements in a suitably smaller tray, 20 ounces of working developer may be sufficient, provided only a small number of prints are to be made. Coming to your particular problem, let us say that you make 8 by 10 or 11 by 14 bromides. Instead of using a single 32-ounce bottle, buy four eight-ounce bottles or eight four-ounce bottles and distribute the 32 ounces of stock solution in the four or eight bottles, as the case may be. Thus, every time you open a bottle of stock solution you will empty it completely. This will solve your oxidation problem; it will also save measuring out the required stock solution each time you mix new developer.

Q. **How can I overcome the nuisance of vibration when taking pictures at home of still lifes, or other pictures requiring relatively long exposures?—H. F.**

A. Your question seems to imply that you have recently been experiencing some trouble in this regard and that your carefully made negatives have "come out" with evidences of camera shake, although you thought you had taken every precaution to avoid this. Floor shake is doubtless your principal trouble, so our best suggestion is that when you undertake any photography

of this sort at home, you do so after the family has gone to bed and street activities are relatively at a stand-still. With no one moving about the house to disturb a shaky floor and with yourself seated during the course of the exposure, operating the release with a long cable release, you should have no further trouble.

Q. What do you recommend as the most suitable wood to use for making a grid for a darkroom sink?—N. H.

A. Redwood 1 by 2 inches has been found completely satisfactory. It is inexpensive and will stand up for a long time without warping.

Q. In developing miniature negatives do you think it is sufficient to test the temperature of the solution in the storage bottle and then pour it directly into the developing tank?—G. A.

A. There is sometimes a real difference between the temperature of a developing solution while in the storage bottle and what it becomes when poured into a developing tank. It is suggested that the better method is to test the temperature in the storage bottle and, after bringing it to the point where it should be, pour it into the developing tank, where the temperature should again be tested. If it is then under or over the required temperature it should be brought up or down as required. When the temperature is just right, turn out the darkroom light, roll the film strip onto the reel in total darkness, immerse the loaded reel, cover the tank, and there you are.

Q. I'd give my hat to learn how to avoid forgetting to buy essential chemicals and other items when they have handy in the darkroom, [illegible] on a wall, with a pencil dangling close by, and write down your requirements whenever a particular supply is getting low. Make it a point to replenish that supply the same or the very next day.

Q. How can one overcome the illusion created by a brilliant, colorful ground-glass image in reflex cameras so that compositional values are not distorted by depth and color that do not appear in monochrome rendering?—J. L.

A. This ordinarily comes with experience, for most reflex camera users eventually learn to disregard the colors and consider only the compositional and tonal values. In the meanwhile, you will probably find it useful to cover your lens with a blue filter when composing your subject, being sure to remove the filter before making the exposure unless, of course, the blue filter is required.

Q. Is it inadvisable to use an exposure meter constantly? Must it be considered a crutch for a cripple to lean upon and to discard as soon as possible?—S. E. L.

A. You can take pictures without an exposure meter, to be sure, but you can do a better job with one. The more experienced the photographer, the less need he has for the constant use of a meter. Nevertheless, a meter is today being used even by men of long experience, for light intensities are often very deceiving and even the best find it useful to check up on their guesses before making important shots. The exposure meter is far from a crutch; it more closely resembles the friendly presence of a wise companion who invites you to listen to his counsel, at the same time encouraging you to do your own thinking. The more experienced you become in judging exposures the less you will need the constant use of the meter, but if you are wise you will never discard it, for when in doubt the meter will make it possible for you to say: "I know it is so" rather than "I guess."

Q. I seem to find it difficult to wipe dirt and dust off my enlarging camera after a period of neglect in this regard. What do you recommend?—K. B.

A. Cheese-cloth and a dose of 3-in-1 oil is one of the best cures we know in this case. Not only does a good wiping with this oil clean the dirt from the housing, pillar, and so on, of your enlarger, but it imparts a pleasant, bright appearance that will surprise you. If, after once cleaning the enlarger properly with this treatment, you take a minute or so every time you use the equipment to wipe it off with a clean, dry, lintless cloth, you will find that the finish will remain clean and bright for a considerable length of time.

Q. What does one do about drinking water in the darkroom where every container may be spattered with developer or hypo spots?—R. M.

A. A glass turned upside down on a clean shelf will always provide a clean receptacle. Or you can provide a peg set in the wall at an upward angle, over which the inverted glass is placed, out of the way and protected **single weight and double weight paper?—D. K.**

A. Only the weight—and the price, the cost of the double weight being considerably higher than that of the single weight. The emulsion is the same. Some papers are available only in double weight and in that case, of course, there is no choice, but most papers may be had in either weight.

Q. When working steadily in the darkroom for a considerable period it sometimes happens that I run out of dry toweling. Possibly you have, too. What has been your experience?—W. J. A.

A. The same, and here's the cure: Paper toweling on a rack. It is cheap, wonderfully absorbent, and singly detachable from the towel roll with one hand.

Q. Do you know of some effective method of imparting density to a thin negative without the bother of intensification?—R. S.

A. While nothing can really take the place of a good intensifier, some workers have occasionally found that a fairly workable substitute in emergencies is the use of a light yellow filter capped over the enlarger lens. This prolongs the exposure, of course, though this disadvantage usually can be overcome to some extent through the use of a large diaphragm opening.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

TUBES for telescopes afford opening for individuality of design, and those shown in Figures 1 and 3 are worth study for ideas. Figure 1 represents a 10", $f/8$ reflector made by C. I. Mitchell, a dealer in sporting goods at Temple, Texas, and its tube rotates efficiently within the retaining bands on ball-bearing roller-skate wheels. It also rotates

Figure 1: **Mitchell, of Texas**

the eyepiece in a horizontal position. In the old days of sail many a sea-captain had just such an arrangement on his bunk, to keep it level. The polar axis is a differential housing with roller bearings, and the brake to make the telescope stay put when set on an object is applied to a brake drum attached near this housing. The declination axis is 3" steel tubing—a generous allowance for rigidity. Weight of telescope, 700 pounds. There is a flea-power electric drive which works through a V-belt with idler. The finder was made from a 5.50-diopter spectacle lens plus the lens from a pocket magnifier, and the maker states that he found a sighting post inside the tube superior to cross-hairs. The telescope is mounted above a level garage roof, on a heavy wooden structure of posts, which does not touch the building, and there is a run-off roof over it. "Fifteen months of my spare time were spent to build this 'scope," Mitchell writes. He states that he would like to correspond with other amateurs.

FIGURE 2 shows the observatory and Figure 3 the telescope owned by Mrs. Marion Grant Bowen, of Carson City, Nevada, who was helped in the construction by a brother. The ground floor of the 16' by 22' observatory literally has the comforts of home—a foyer, dressing room, bathroom, and library. Many a mere man dreams of such a retreat, well out of shouting distance from domestic appeals for help and, as Ellison put the expression, "with a lock on the door and the key in his pocket." Access to the 11' dome is by way of a hatch that opens outdoors, thus shunting warmed air away from the instrument. The telescope (Figure 3) is an $f/6.9$, 10" reflector with unusually clean tube, built of cast aluminum rings held on Shelby tubing by opposing nuts. Internal diameter, 12". Setting circles read to 5' in R.A. and 1° in declination. There is a slip ring. Cell carries a 9-point floatation system. Altitude at Carson City is 4650 feet, with probably enviable seeing conditions. These data were furnished by Robert Blackmore, 132 N. Arlington Ave., East Orange, N. J.

AMATEURS who sometimes complain of disadvantageous working conditions may take renewed courage after studying Figure 4, which shows the sky-hole in the level roof of a typical Brooklyn residence, with the hatch cover off. William S. von Arx, 573 Monroe St., Brooklyn, N. Y., the author of the chapter on "Stellar Photography," in ATMA, nightly sits on a temporary cross-board at ceiling level 18" below this roof and operates the equipment shown, getting

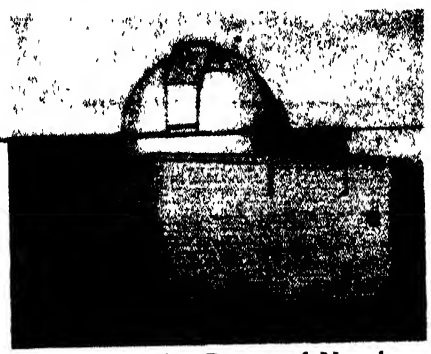


Figure 2: **Mrs. Bowen, of Nevada**

excellent results despite the strong sky-glare of the great city. He describes this equipment as follows:

"THE photographic equatorial shown carries a 508-mm (20") focus, $f/6$ Eastman Aerial objective, 3.3" aperture which just covers a quarter plate nicely. The area of sky included per plate is about 11° by 14°, of which 10° square yields excellent definition—scale: 1 mm=400 seconds. The guide telescope mounted on the camera is a 72-mm triplet of 21.5 focus, provided with the usual reticle and a ¼" eyepiece. The 'carbureter' attached to the lower end of the camera is a small clock which beats four times per second, permitting the observer to count seconds with more precision than 'one-chimpanzee-two-chimpanzee-three-chim . . .' and also relieves him of the necessity of removing his attention from the guide star in order to know how far the exposure has progressed. Near the clock is a thumbscrew for moving the plate holder in R. A.—multiple exposure plates. The rubber bulb and hose operates the 4" Packard-Ideal shutter (square panel over the lens), which works with a reassuring clatter but without noticeable vibration. Exposures as short as 1/5 sec. can be successfully managed by biting the bulb. This method is often pursued in times of bad seeing. Operating the shutter with the teeth leaves both hands free for guiding; the latter being a busy business at times. More than this, a mental count is kept of the seconds during which the shutter is open.

"Since the mounting is unhoused it was necessary to make it easily demountable. To accomplish this the yoke simply pulls out of the north and south bearings, thus reducing the mounting to three easily handled units. One by one—according to a very rigid sequence—the parts are stowed below the roof level and the hatch cover drawn to. Three sockets were cemented to the roof when the polar axis was considered well set, so that the polar adjustment is identical each time. It has proved to be sufficiently accurate to continue exposures over two or three nights—taking the whole mounting down between times—without perceptible damage to the images even under microscopic examination.

"With the exception of moving parts, the camera and mounting are made entirely of wood finished with lead gray paint, so that it may be [illegible] white pine, all well seasoned, quite rigid and conveniently light in weight. Where necessary the wooden members are reinforced with heavy corner irons and lag screws.

"The clock drive built into the south pier is of somewhat unconventional design. Suitable worms being quite expensive, it was decided to use a friction drive instead. A smooth, accurate motion in R. A. is secured by a small round-belt pulley bearing directly

Figure 3: **The Bowen reflector**

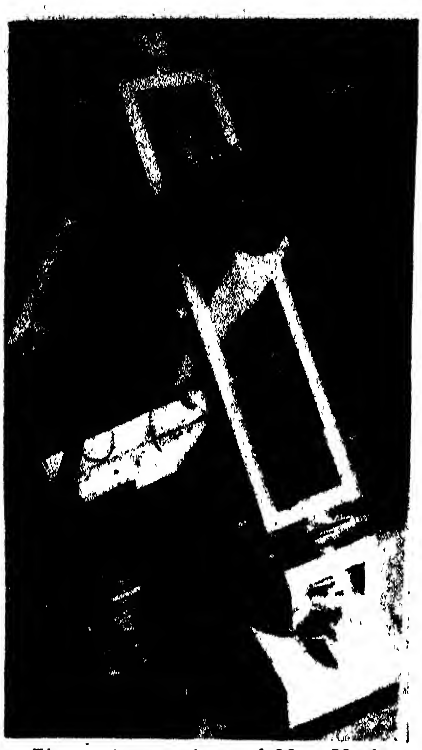


Figure 4: von Arx, of New York

on a large (12") "V"-belt pulley having a length of ⅝" o.d. high-pressure cord rubber tubing cemented in the groove. The small pulley is driven by a train of worms and gears originating in an electric phonograph motor. The ratio is such that the motor runs at about 40 percent top speed and 80 percent standard speed. For adjusting the rate of the clock a hand screw (on the right of the S. pier) which has a fine metric thread bears any amount over the sidereal rate and holds it there—for widening objective prism spectra known amounts. On the north side of the pier is a third control within easy reach from the eyepiece, for momentary acceleration as needed in guiding. A switch on a length of cable 'cuts the gun' as necessary. With the second control down and this switch in hand, a star image can be made to commute between two lines in the reticle at a uniform rate as many times as is necessary to build up an image of a star's spectrum. With the switch 'on,' the image advances. When it reaches the end of its prescribed course the switch is thrown 'off' and the diurnal motion of the earth carries it back to its starting point. The objective prism spectrograph (f/4.5, 10.5-cm. focus, with a 60° crown prism) clamps on the east trunion of the Dec. axis at an angle of median deviation, which permits the guide telescope to be used on the star under observation.

"The camera is also equipped with a 15° crown objective prism, a 'normal' grating (0.99Δm) and a 90° prism for photographing the North Polar Sequence since it is in the blind spot of the mounting. This blind spot is a very definite disadvantage but, pound for pound, few mounting designs equal the stability of the double yoke. Then, too, as those who work with the Hooker telescope solemnly affirm, 'There is nothing interesting north of plus 67 anyway!'"

LEST new readers of the magazine now run away with the idea that, in order to

Figure 5: **Mosher, of New York**

be an amateur telescope maker one must be able to concoct creations like those just described, Figure 5 is inserted in order to show a more typical maiden effort such as those who successfully finish instruments of a more ambitious kind have themselves begun on. This is a 6" reflector made by John J. Mosher, 26 Lansdale St., Rochester, N. Y., and the parts of the mounting are made up of pipe fittings—a reducing T, a short nipple, a 45° elbow, another short nip, and other standard fittings for the upright. As such fittings often have some looseness and shake, setscrews in tapped holes take this up. No blueprints for specific telescopes such as this are available, each instrument being the [illegible] based on general creation but the bug gets into his blood stream and he discovers he wants a new and more ambitious one about as often as his wife wants a new hat. Well, it will cost him something *less* than he would otherwise spend in the same time burning up gas on the road, overeating in restaurants, or making whoopee with some well-upholstered platinum or excelsior blonde in night clubs.

Figure 6: **Hansen, of Massachusetts**

WHILE a 6" diameter is the optimum size for the beginner, a very few make 4" or 5" sizes and Figure 6 shows a 4" "Baby Grand" made several years ago by J. P. Hansen, Framingham, Mass., who says it "works great," and cost "around $25." The stand is from an old drawing board, the patterns were homemade and the castings were made in a local foundry, while others were cast in aluminum in the home basement, using metal melted in the furnace, the molds being of plaster of Paris. Hansen wisely mentions that such molds must be thoroughly dried. He says he was over-anxious to get the mounting finished, poured the metal into wet molds and "the whole business blew up [illegible] and attractive appearance and, though it is small, it has a much better mounting than the average beginner's No. 1 job usually is or even needs to be.

Figure 7: **Wilson, of West Virginia**

Figure 8: **Wheeler, of So. Carolina**

ANOTHER simple telescope—a maiden effort—is shown in Figure 7, this time an 8" but with simpler mounting than the previous one. H. C. Wilson, 877 Chester Road, Charleston, W. Va., is the maker. Tube, galvanized iron with heavy wire rolled into the top for stiffening. Mounting, 4" pipe fitting plus an old tree stump—very solid. Cost, $27.50.

SQUARE tubes for telescopes function as well as round ones and are much easier to make. Figure 8 shows how Paul Mowbray

Wheeler, Professor of English at Winthrop College, Rock Hill, S. C., converted a cypress box into a tube, adding scantlings in the form of a rectangle within which this tube, with its 7" mirror, was pivoted. There are bearings at top and bottom ends of the rectangle ("double yoke" is the technical term for this) and the whole is a thoroughly efficient and rigid kind of mounting, simple to make, easy to take to pieces or erect, inexpensive. The world's largest telescope, the 100" reflector at the Mt. Wilson Observatory, is mounted similarly. The large steering wheels on the two axes are the maker's idea, being used for turning the tube in declination, the astronomer's equivalent of latitude, and in right ascension, the equivalent of longitude.

ANOTHER double yoke mounting appears in Figure 9, the photograph having been sent in by R. P. Hassler, of R.F.D. 1, Leverne, Minn. The tube is of metal and the yoke and frame are made of steel channels and an old motor car chassis. This is a 10" telescope—rather beyond beginner size.

"IF paint is applied to galvanized iron or zinc, it will peel off after a time, but the following treatment will make it stay on," according to Lawrence A. Cox, 47 Upper Green East, Mitcham, Surrey, England.

Figure 9: **Hassler, of Minnesota**

"Add ½ oz. dilute sulfuric acid to one pint of saturated solution of copper sulfate. If this solution is swabbed on to the metal liberally, it will immediately blacken the surface. It should not be wiped off but allowed to dry on, and the surface then given a coat of gold size. Afterward it can be dead-blacked or painted otherwise as necessary."

WHEN well-meaning friends insist on labeling you, even in public print, an "astronomer," often to your embarrassment, or where they do not realize what a real astronomer is and what an amateur astronomer isn't, the following quotation taken from an account of the life of the late Ambrose Swasey, the famous professional telescope builder, by Prof. J. J. Nassau and published in the *Journal of Applied Physics* (New York) might be read to them: "When once Mr. W. H. Crocker of San Francisco remarked, 'Why, Mr. Swasey, you are an astronomer,' he replied, 'When I was a boy, my father kept a great number of sheep and when working around the barn and with the sheep, some of the wool rubbed off on me, but that didn't make a sheep of me.'"

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

DEATH BEGINS AT FORTY is a pictorialized record of the automobile accident problem in the United States during 1937. A number of interesting charts and diagrams show graphically what may happen to you if you are not "a safe driver." *The Travelers Insurance Company, Hartford, Connecticut.—Gratis.*

HASTELLOY—HIGH-STRENGTH ALLOYS FOR CORROSION RESISTANCE is a 36-page booklet that presents complete information on four alloys which have been developed to withstand certain severe conditions of chemical corrosion. Complete details are given regarding chemical and physical properties, available forms, methods of fabrication, and typical successful applications. *Write for Bulletin 538A to Scientific American, 24 West 40th Street, New York.—3 cents.*

PETROLEUM FACTS AND FIGURES, Fifth Edition, 1937, contains about 250 pages and is the first to be published by the petroleum industry trade association since 1931. Effort has been made to incorporate all pertinent data available regarding the industry, and much of the statistical data is presented in pictorial graphs and charts. The subject matter covers utilization, production, transformation of raw materials, transportation, markets and prices, and so on, covering the entire field of petroleum products. All information published in the first four editions is included in this one volume, with all data modernized. *American Petroleum Institute, 50 West 50th Street, New York City.—75 cents.*

KOPPERS SPECIFICATIONS is a booklet of particular interest to architects and engineers. It gives data regarding standard roofing specifications, including spray pond roofs which permit the re-use of water in air-conditioning systems and water-cooled roofs to insulate the upper floors of buildings. *Write for Bulletin 538B to Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE WORKER IN GENERAL MOTORS, by Alfred P. Sloan, Jr., tells the story of employment in General Motors plants, particularly as concerns wages, hours of employment per year, and living conditions available. *General Motors Corporation, Detroit, Michigan.—Gratis.*

SAVINGS AND AMERICAN PROGRESS is a discussion of the relation of wealth-creating enterprises to employment and the American standard of living. Illustrated with a series of simplified charts. *Write for Bulletin 538C to Scientific American, 24 West 40th Street, New York City.—3 cents.*

AMERICAN PLANNING AND CIVIC ANNUAL is a 404-page book, stiff covers, presenting the best thoughts of specialists in civic planning and giving accounts of recent events which have taken place in the broad field of national, state, and community park and building programs. The price of the volume includes membership in the American Planning and Civic Association. Illustrated with a number of photographs. *American Planning and Civic Association, 901 Union Trust Building, Washington, D. C.—$3.00.*

EXPLOSIVES FOR FIELD CLEARING gives a description of practical methods of blasting stumps and boulders. The proper methods for placing the explosive charges for different types of stumps and boulders are described and illustrated with diagrams. Instructions are given for the protection of buildings. *Write for Bulletin 538D to Scientific American, 24 West 40th Street, New York City.—3 cents.*

VIVID PORTRAITS gives complete and specific directions for taking portraits with ordinary cameras. It tells how to avoid stereotyped treatment. *American Photographic Publishing Co., 428 Newbury Street, Boston, Massachusetts.—50 cents.*

AIR CONDITIONING, REFRIGERATION, HEATING is a compact catalogue describing equipment for these purposes in the home as well as in offices and industrial plants. Descriptive and dimensional data are included.—*Write for Bulletin 538E to Scientific American, 24 West 40th Street, New York City.—3 cents.*

BOAT AND MOTOR SELECTOR is a cardboard "slide rule" which tells at a glance just exactly what types of outboard motors can be used on certain types of boats. *Evinrude Motors, Milwaukee, Wisconsin.—Gratis.*

AN EXPERIMENTAL STUDY OF THE PROBLEM OF MITOGENETIC RADIATION, by Alexander Hollaender and Walter D. Claus, is the detailed account of careful, two-year experiments which seem to demonstrate that the famous Gurwitsch rays, often called "onion rays," concerning which as many as 600 scientific papers have been published, never existed! *National Research Council of the National Academy of Sciences, Washington, D. C.—$1.00.*

BULLETIN OF THE TEXAS ARCHEOLOGICAL AND PALEONTOLOGICAL SOCIETY, Volume 9, is a 244-page, illustrated annual containing a dozen papers describing archeological research in the western states. *Dr. Otto O. Watts, Hardin-Simmons Building, Abilene, Texas.—$3.00.*

INDUSTRIAL ADVANTAGES OF A PATERSON LOCATION is a survey of basic conditions in that New Jersey industrial center. It covers briefly the convenience of Paterson to markets, its proximity to auxiliary industries, transportation available, fuel and power costs, water supply, labor supply, and so on. *The Industrial Commission, Paterson, New Jersey.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Light but Strong

A RATHER important patent for an inside frosted electric light bulb was recently held to be valid and infringed, by the Circuit Court of Appeals for the Second Circuit. The patent, numbered 1,687,510, relates to an electric light bulb in which the interior surface is frosted in such a manner that the bulb is strong enough for commercial purposes. The Court found that many attempts had been made to provide inside frosted electric light bulbs prior to the patent in suit. Bulbs frosted in this manner, however, were so fragile that they would break when subjected to ordinary usage.

The inner surface of an electric light bulb is ordinarily frosted by subjecting it to a sand blast or to an acid etching bath. This results in a multitude of tiny pits or depressions in the surface of the glass. The inventor of the patent in suit discovered that it was the sharpness of the pits and depressions that was responsible for the weakness of the bulbs. He found that if he subjected the frosted surface to an additional weak acid bath for a short period of time the sharp angular pits and depressions were converted into rounded crevices and the strength of the bulb was greatly increased. As a result of this invention, inside frosted electric light bulbs became practical and went into extensive commercial use.

Prior to the patent in suit, focusing screens for cameras had been treated in a similar manner to obtain certain optical effects. No one appreciated, however, that the strength of an inside coated electric light bulb could be increased in this simple but effective manner. The Court accordingly came to the conclusion that the solution of the problem in this manner amounted to invention, and it sustained the validity of the patent. With regard to the apparent simplicity of the invention the Court stated:

"Like all problems when solved, it may be argued to be simple, but where, as here, it appears that the accomplishment had eluded the search of those interested in finding its solution until this inventor's contribution, he should be accorded the fruits of a patent for his accomplishment."

Reversal

ON this page of the April, 1938, issue of Scientific American under the heading "Price Cutting," we discussed a rather important suit decided by the New York State Supreme Court regarding the so-called Fair Trade Act.

The Fair Trade Act permits a producer or distributor to fix by contract the resale price at which merchandise bearing his trade mark name or brand may be sold. The Act also provides that knowingly selling merchandise below the price fixed in the contract constitutes unfair competition. Similar Acts have been passed by many of the States and an Act providing for contracts in interstate commerce has been passed by Congress.

In the case decided by the New York State Supreme Court a retailer sought to take advantage of the provisions of the Act and brought suit against a competitor for selling merchandise below the price fixed by the manufacturer or distributor. The Supreme Court decided that the Act provided for vertical, as distinguished from horizontal, price maintenance and held that a suit for unfair competition under the Act could only be brought by the distributor or manufacturer.

An appeal was taken by the retailer to the Appellate Division of the Supreme Court and the decision of the lower court has now been reversed. The Appellate Division points out that the statute provides that an action for unfair competition may be brought "at the suit of any person damaged thereby." The court then concludes that the retailer was damaged by the price cutting of his competitor and accordingly under the express wording of the statute was entitled to maintain the suit.

In all probability an appeal will be taken to the Court of Appeals of the State of New York and the question of who may maintain a suit for unfair competition under the Fair Trade Act in New York State will not be definitely decided until the decision of the Court of Appeals is handed down.

Incubation

THE Circuit Court of Appeals for the 6th Circuit has recently decided a suit of more than ordinary importance involving a patent for the method of incubating eggs. The Court held that the sale of an incubator capable of being used in accordance with the patented method, coupled with the distribution of catalogs and advertising matter teaching the use of the incubator in accordance with the patented method, constituted contributory patent infringement.

The patent in suit taught the method of incubating eggs whereby the eggs are maintained at a constant temperature throughout the incubating and hatching period. During the incubating period the air surrounding the eggs is maintained at a relatively low humidity while during the hatching period the air is maintained at a relatively high humidity.

The defendant sold an incubator which was capable of being operated in the manner described and claimed in the patent, and distributed catalogs to its customers describing the patented process. The Court found that this action on the part of the defendant constituted contributory infringement and enjoined the sale of any incubators "capable of being used to practise the patented method and directly or indirectly represented as being capable of such use."

This case is of importance because, even though the patent in suit related only to the method of incubation, the Court enjoined the sale of the incubator *per se*. Another interesting point was involved in this case. One of the defenses was that the method had been in public use more than two years prior to the application date for the patent and that therefore the patent was invalid. The Court found that whatever public use there was took place in Canada and accordingly rejected this defense because the defense of prior public use must be based upon use in the United States.

Valid

IT is well established that in a suit for patent infringement brought by the purchaser of a patent against the seller of the patent, the seller cannot defend the suit on the grounds that the patent is invalid. The reason for this rule is to be found in equity and good conscience. Certainly a person who induces another person to purchase a patent should not be permitted later to assert that what he sold the second person was actually of no value.

In a recent suit for patent infringement decided by the Circuit Court of Appeals for the Ninth Circuit, one of the patents in suit had been sold by the defendant to the plaintiff, and as to this patent the Court stated:

"As to patent 1,511,699 it is clear that appellant by his assignment to appellee is estopped to deny the validity of the patent."

The defendant argued that this rule was not applicable to the present case, on the rather interesting theory that he actually did not have any interest in the patent at the time that he purported to sell it to the plaintiff. The Court correctly overruled this contention, however, and pointed out that the defendant agreed to assign, and purported to assign, whatever title he had to the patent and that this action gave rise to an estoppel to deny the patent's validity.

Diaper Doll

THE popular dolls, which have been sold extensively throughout the country, which wear diapers, drink from bottles, and simulate some of the normal biological functions of a baby, have recently been involved in a suit for unfair competition. The plaintiff in the suit sold his doll under the name "Q-T Baby Doll," and its carton bore the following legend: "Drinks its bottle, wets its diaper."

The defendant sold its doll under the name "Beauty Doll Baby," and the Court found that it sold its doll in a carton similar to the plaintiff's, and that the carton bore a similar legend. The Court concluded that the defendant's conduct constituted unfair competition, pointing out that the name "Beauty" was similar in sound to "Q-T", and that the use of the same legend and style of package was likely to cause confusion.

Books SELECTED BY THE EDITORS

THROUGH SCIENCE TO PHILOSOPHY

By Herbert Dingle, Asst. Prof. Astrophysics, Imperial College of Science and Technology

AN outstanding book by a noted astrophysicist, who is equally noted for his incursions into the philosophy of science, and especially for his attacks on what he calls the "paralysis of the reason with intoxication of the fancy" of men such as Eddington, Milne, and Dirac, because of their tendency to arrive at irrational conclusions as a result of starting with convenient assumptions not based on actual observation or experiment. In this work he is also critical of Jeans. "I am frequently amazed," he writes, "at the easy assurance with which writers speak of the latest gropings of physics as though they were eternal verities." The average reader of the present book on science and common sense, the scientific method, time, causality, indeterminacy, free will, and current philosophies, will not find it light going, since it is "deep stuff." (363 pages, 5¼ by 9 inches, 18 illustrations.)—$5.20 postpaid.—*A. G. I.*

THE MODERN CONJURER

By C. Lang Neil

ALL phases of modern magic are treated in the pages of this book, from the simple manipulation of cards through card tricks, tricks with coins, billiard balls, handkerchiefs, and so on, to parlor tricks and puzzles requiring no particular skill. The first chapters are devoted to the mannerisms and gestures of the performer, his clothing as it can best be adapted to his work of trickery, his wand, and the conjuring tables that are of such great assistance in modern magic. (386 pages, 5½ by 8½, profusely illustrated with photographs.)—$2.15 postpaid.—*A. P. P.*

BRITTANY PATROL

By H. Wickliffe Rose

THIS is the sort of story which verifies the threadbare old saying that truth is stranger than fiction. It is an intimate account of the operations of the so-called "Suicide Fleet" which patrolled the waters of the coast of France to guard against submarines during the World War. (367 pages, 6 by 8¾ inches, 43 photographic plates.)—$3.70 postpaid.—*F. D. M.*

THE ART AND SCIENCE OF MARRIAGE

By Esther B. Tietz, M.D., Ph.D. and Charles K. Weichert, Ph.D.

THE two authors are, respectively, resident physician at Longview State Hospital in Cincinnati and Associate Professor of Zoology at the University of Cincinnati, and the book has an introduction by Dr. Morris Fishbein, Editor of the *Journal of the American Medical Association*. Dr. Fishbein states that, while there have been numerous books on the same general subject written by psychologists, ministers, sexologists, and others, there has usually been overemphasis on some one aspect of it; the present authors' presentation is well balanced. Eighty percent of the text describes the body and its functions, including the reproductive system. The 20 percent by Dr. Tietz covers courtship and marriage and is so to the point and so practical that it could hardly be more so, since it does not mince even a word. Recommended, not to children or easily shockable elders, but to engaged couples. (269 pages, 8¼ by 5½ inches, unillustrated.)—$2.65 postpaid.—*A. G. I.*

MANAGING YOURSELF

By Milton Wright

BOOTSTRAP book. Read it, do what it tells you and you will have succeeded in elevating yourself by your own bootstraps into a better personality—more able, more likable, therefore more successful. How to concentrate, strengthening your memory, also diagnosing that tired feeling and finding mental energy, organizing yourself, using your imagination, establishing confidence, acquiring physical fitness, learning to think straight, and, finally, managing other people—this is its scope. It is most readable, intensely human, practical, and applicable in our battles with everyday life to most of us who aren't entirely hopeless. It is suitable for self-analysis, is not just another inspirational book full of sweet sentiments, and ought to help almost anyone to improve himself. (319 pages, 5½ by 8 inches, unillustrated.)—$2.65 postpaid.—*A. G. I.*

CHEMISTRY, MATTER AND LIFE

By Stephen Miall and Lawrence Mackenzie Miall

"WE have tried to describe in language that any educated person can understand some of the main principles of chemistry, the nature of matter, and some of the chemical changes that take place in living plants and animals," say the authors. The result is a very condensed summary—one to be suggested to those who are *reviewing* facts already studied. (292 pages, 7½ by 5 inches, 8 illustrations.)—$2.50 postpaid.—*B. M. N.*

MOTION PICTURES IN EDUCATION

By Edgar Dale, Fannie W. Dunn, Charles F. Hoban, Jr., Etta Schneider

TEACHERS and administrators in various branches of education will find here a summary of the literature which has grown up around the motion picture as an aid in education. Such a background will assist these workers to evaluate what has been done in this field and to proceed to plan what can be done in the future with this modern educational medium. The book is divided into six parts: The Administration of Visual Aids; Teaching with the Motion Picture and other Visual Aids; Selecting Instructional Materials; Film Production in Schools; Experimental Research in Instructional Films; Teacher Preparation in Visual Education. (472 pages, 6 by 9 inches, unillustrated.)—$2.70 postpaid.—*A. P. P.*

DICTIONARY AND MANUAL OF FIREWORKS

By George W. Weingart

SEVERAL years ago we had occasion to dig up a book on pyrotechnics for one of our readers and discovered at that time that they are scarcer than the proverbial hen's teeth. This little volume seems to be the first discussion of the subject which has been published in many years. It is useful primarily to those who have charge of fireworks displays at fairs, celebrations, and the like, for it gives instructions in the safe and most effective use of explosive types of fireworks, flames, and flares. There are also included quite a number of formulas for making colored flares, fusees, torches, and some other of the less dangerous display fireworks. An explanation of many of the chemicals used leads off the book and information is given as to where they may be obtained and the approximate price. This is a small volume, but is packed with information. (170 pages, 6 by 9 inches, illustrated with many drawings and several colored plates.)—$3.15 postpaid.—*F. D. M.*

RETROSPECT

By T. A. Rickard

THE autobiography of a noted mining engineer and editor of mining journals of first rank. Replete with incident and color, travel and the romance that go with it. Inspiration for the youthful reader to go and do likewise—that is, to succeed—and for the older who read vicariously. Of vast interest to mining men. (402 pages, 6 by 9 inches, 4 illustrations.)—$3.15 postpaid.—*A. G. I.*

OFF WITH THEIR HEADS

By Victor Wolfgang Von Hagen

A NARRATIVE of adventure among the head-hunters of the Upper Amazon. Woven in with the account are many anthropological sidelights on the food, dress, housing, superstitions, and customs of these people. (220 pages, 5½ by 8½ inches, 15 illustrations, map.)—$3.20 postpaid.—*A. G. I.*

THE MODEL RAILROADER, VOLUME FOUR

Edited by A. C. Kalmbach

AS in years past, this volume comprises the complete series of issues of the magazine which is published for that large group of fans who delight in the intricacies of model trains and railroads. It is an attractive collection of data on the construction of locomotives and all the general equipment for model railroads. It is well illustrated with pictures and diagrams and

carries numerous advertisements of dealers in all the parts and equipment that may be needed. (480 pages, 10½ by 7 inches.)—$3.20 postpaid.—*F. D. M.*

TELEVISION CYCLOPEDIA

By Alfred T. Witts, A.M.I.E.E.

DEVELOPMENT of the television art has brought with it a nomenclature peculiar to itself. In this volume the author lists those words and phrases, an understanding of which is necessary to an understanding of television in all its ramifications. An attempt has been made to provide concise knowledge, as distinct from mere definitions of words and phrases, and the attempt has been admirably successful. (152 pages, 6 by 9 inches, illustrated with drawings.)—$2.40 postpaid.—*A. P. P.*

SCIENTIFIC METHOD

By F. W. Westaway

A MOST comprehensive thick chunk of a volume is this one—with a content affording prolonged and serious study. This omnibus of the scientific method is for those who wish to learn to think straight—the true "scientific method" we hear so much about and something that is most difficult to hold fast to even if the desire is present. Words and their elusiveness, the function of logic, induction, general principles of investigation, observation and experiment, the analysis of phenomena, hypothesis, probability, error—these are the subject matter of some of the chapters. Numerous others explain the systems of thinking of most of the great philosophers; still others quote long examples of good scientific thinking by great scientists and thinkers of the past and present. The author has a special flair for making difficult things as clear as possible. The serious "graduate" from this book will rightly feel that he has "been to college" and had his thinking processes melted down and recast. (588 pages, 5 by 8 inches, 35 illustrations.)—$3.95 postpaid.—*A. G. I.*

OUR RHEUMATISM

By Oscar Parkes, O.B.E., M.B., Ch.B.

A SIMPLE and easily understood explanation of rheumatism and its allied conditions, written by a British author and physician who has himself been rheumatic. It also includes descriptions of some of the newer methods of treatment, such as the ultra-short wave, octazone gas and the traction couch. (106 pages, 5½ by 9 inches, 14 illustrations.)—$2.00 postpaid.—*A. G. I.*

THE STORY OF TUNNELS

By Archibald Black

A BRIEF survey of ancient tunneling methods carries this volume quickly into the development of the "shield" method of tunneling, in such wide use today. It discusses the first "shield" of Barlow and Greathead, and the one which was independently invented about the same time by Alfred E. Beach, one-time editor of Scientific American. Details of the construction of many important tunnels and, later, subways in this country and abroad make of this not only an interesting volume, but one which has great value as a reference. Some details of the Moscow subway are also given, as well as a concluding chapter entitled "Unfinished Business," which gives the history of the attempts to devise a satisfactory plan of tunneling under the English Channel. (245 pages, 6¼ by 9¼ inches, illustrated.)—$2.95 postpaid.—*F. D. M.*

EXPERIMENTAL RADIO

By R. R. Ramsey

THOSE who are experimentally inclined and who like to demonstrate for their own satisfaction the various phenomena of radio reception will find in this, the fourth edition of an old standby, modern data that will enable them to experiment to their heart's content. The majority of the experiments are so arranged that they can be conducted with the standard types of current supplies available today, rather than with the battery set-ups so common in the experiments of earlier days in radio. The book covers all phases of radio and includes descriptions of experiments in television and wired wireless. (196 pages, 6 by 9 inches, diagrams.)—$2.90 postpaid.—*A. P. P.*

AIR CONDITIONING IN SUMMER AND WINTER

By Richard E. Holmes

MANY books on air conditioning have been published in recent years and each new one has seemed to be an improvement over the preceding one. At any rate, this particular volume is more complete than any we have seen recently, giving, as it does, a careful explanation of the fundamental principle underlying all air-conditioning systems, and carrying through discussions of requirements for comfort, the different kinds of systems, the air-conditioning load in summer and winter, heaters, humidifiers, refrigerants and refrigerant tables, and many other pertinent phases of the subject. In a sense it may be considered rather technical, as it has considerable mathematics, tables, and technical diagrams; it is the sort of book that either the graduate engineer or the student would find invaluable as a source of information and reference. (296 pages, 6 by 9 inches, illustrated.)—$3.20 postpaid.—*F. D. M.*

SCIENTIFIC AMERICAN

ADVERTISERS

May · 1938

Advertising Manager
CHARLES H STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY, 35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN, Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 158, No. 5, 35 cents a copy, $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • JUNE • 1938

IT may be that the oil flowing through the "Christmas tree" illustrated on our cover will soon be doing its part in the operation of your motor car. The valves shown are used to control the flow of oil from the well to several different lines. The oil is being forced up by natural gas pressure, sometimes as high as ten thousand pounds to the square inch. After this gas pressure fails, the walking beam shown in the background is placed in service and the oil is pumped from the well for distribution.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, June, 1938. Vol. No. 158, No. 6, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

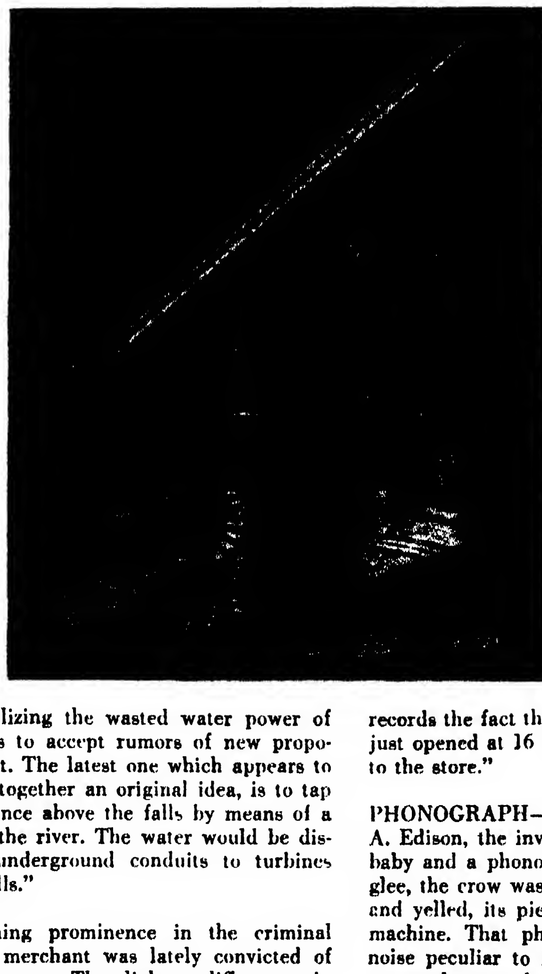
50 Years Ago in . . .

Scientific American

(Condensed From Issues of June, 1888)

SAFETY—"A block signal system, so arranged that a train entering a section of track will set a signal at the end of the section toward which it is moving to 'danger,' and set to 'safety' a similar signal by the same movement, on the section it is leaving, has been patented by Mr. George W. Peterson."

LICK—"The great telescope of the Lick Observatory was mounted in the south dome on Mt. Hamilton in the early part of the present year, and is now . . . practically completed. . . . The pier of the telescope is a rectangular cast iron column weighing 20 tons, built up of four sections rigidly bolted together. . . . The lower section, which at the floor level is 9 by 5 feet, expands into a broad base, 16 feet long and 10 feet wide, resting upon the solid masonry foundation which forms the tomb of James Lick. . . . On top of the pier is a balcony, surrounding the massive head piece which forms the support for the polar axis, a finely finished shaft of steel, 12 inches in diameter and 10 feet long, weighing 2,800 lbs. It is pierced centrally by a 6-inch hole, through which passes a shaft for communicating the motions in declination to the telescope from the balcony."



NIAGARA—"There have been so many false alarms about utilizing the wasted water power of Niagara Falls that one hesitates to accept rumors of new propositions as likely to be carried out. The latest one which appears to have any backing, though not altogether an original idea, is to tap the Niagara River at some distance above the falls by means of a tunnel driven along the side of the river. The water would be distributed by means of lateral underground conduits to turbines placed on the bank below the falls."

CRIME—"Photography is gaining prominence in the criminal courts. With its help a Berlin merchant was lately convicted of crooked ways in keeping his accounts. The slightest differences in color and shade of inks are made manifest in the photographic copy. Blue inks appear nearly white; brown inks, on the contrary, almost black. A contemporary states that the books of the accused were submitted to a photographer, who took off the pages concerned and brought into court the most undoubted ocular proofs of the illegitimate after-entry of some of the accounts. A subsequent chemical test substantiated this evidence."

PSYCHOLOGY—"Too many men make their boys feel that they are of little or no account while they are boys. Lay a responsibility on a boy, and he will meet it in a manful spirit. On no account ignore their disposition to investigate. Help them to understand things. Encourage them to understand what they are about. We are too apt to treat a boy's seeking after knowledge as mere idle curiosity."

AIR CONDITIONING—"An apparatus has been introduced in the Standard Theater, of this city, which in a very simple way is designed to solve the problem of securing a cool auditorium in summer. A fan is placed in the basement which draws air from outside the building and delivers it through the furnace pipes and registers to various parts of the auditorium. The air before it reaches the fan is drawn over ice arranged on shelves. This cools it so that a temperature of 70 degrees is easily attainable. . . . For a single evening's work about ten tons of ice are expended."

TORPEDO BOAT—"Torpedo gunboats and torpedo cruisers are the order of the day everywhere. It is now a long time since our naval authorities first came to the conclusion that, though we must be possessed of some big ships with heavy armament, both offensive and defensive, at the same time a large number of smaller light and swift craft were absolutely indispensable. Not a few critics of distinction have again and again urged that the larger vessels were too costly, and that a million sterling spent on one of these might be much more advantageously laid out on several second or third rate vessels of greater speed. Swiftness is everything as regards torpedo warfare."

LIGHT—"The electric light is getting to play an important part in medical investigations. With a little 'pea light' attached to the end of a slender rod, Sir Morell Mackenzie examines the throat of the German Emperor. The little battery that supplies the electricity hangs around the surgeon's neck."

FIRE—"The *Chemist and Druggist* (London) records the fact that show bottles in the windows of a chemist shop, just opened at 16 High Street, acted as burning glasses and set fire to the store."

PHONOGRAPH—"According to the New York *Herald*, Thomas A. Edison, the inventor, has been interesting himself with his new baby and a phonograph at his home. When the baby crowed with glee, the crow was registered on the phonograph; when it got mad and yelled, its piercing screams were irrevocably recorded on the machine. That phonograph is now a receptacle of every known noise peculiar to babyhood. It is Mr. Edison's intention to make a record every three months."

AND NOW FOR THE FUTURE

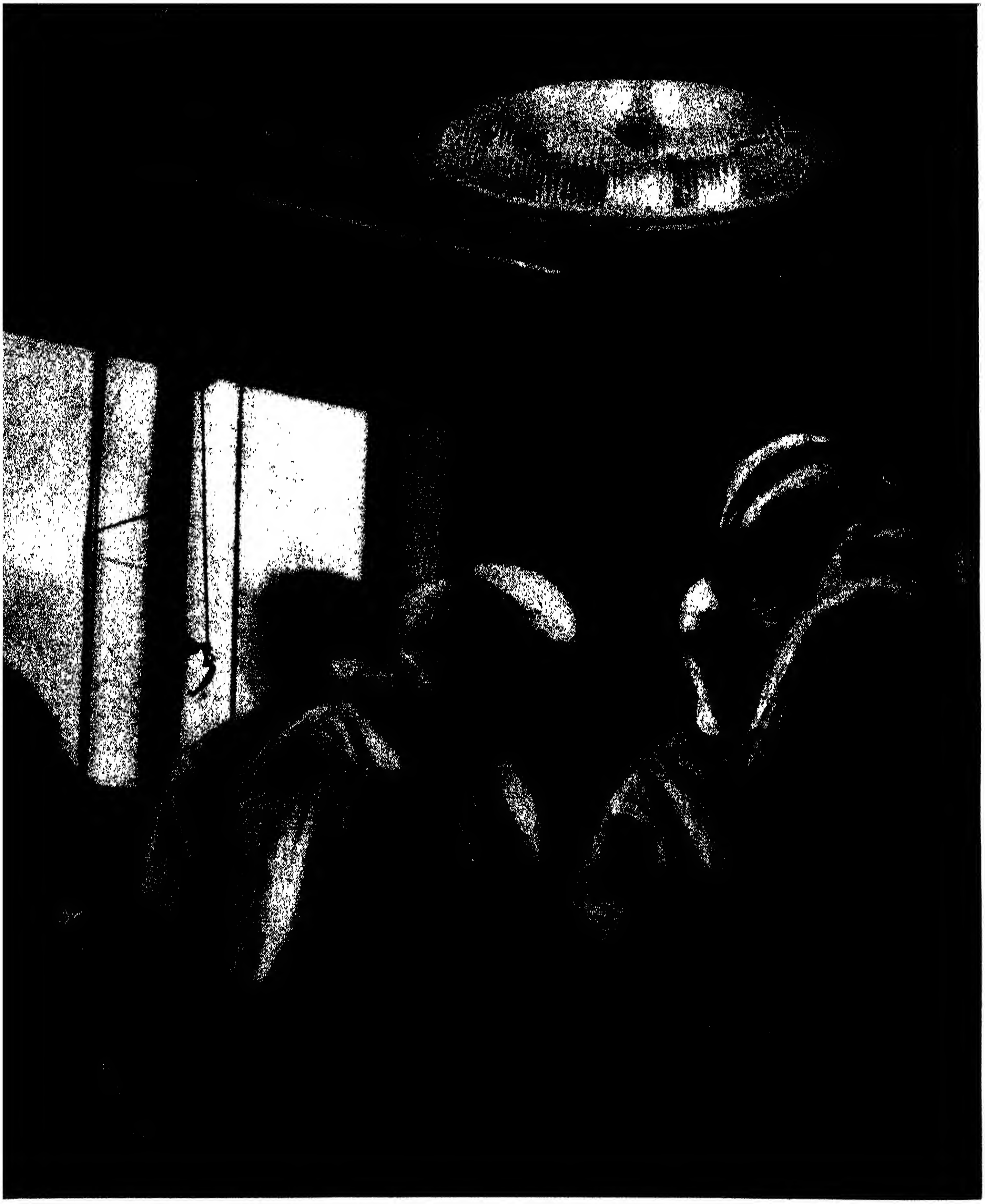
¶Naval strength—a pictorial survey of the present status of the Japanese Navy.

¶Plant breeding—an art and a science, by Keith C. Barrons.

¶Helium—the gas that makes dirigibles safe, by Paul H. Wilkinson.

¶Floods—escaping their wrath by a coördinated reporting system, by Alexander Maxwell.

¶X-particles—where they fit into the picture of modern physics, by Jean Harrington.



MEN IN WHITE UNDER ULTRA-VIOLET

EVEN in the far corners of this operating room, 80 to 90 percent of all bacteria are killed by the newly developed, tubular, ultra-violet ray lamps surrounding the main source of illumination. At the surgical wound, the germicidal effect is practically 100 percent. As reported in the article on page 344, these new lamps are rapidly being adopted by restaurants, food stores, bakeries, butcher shops, and the like.

Through pine forests and jungle-like growth, the dredge *Tampa* moves slowly, improving the Caloosahatchee River

FARMS FOR THE EVERGLADES

Levees, Drainage Canals Permit Reclamation of Mysterious Everglades . . . Soil is Black and Rich . . . Thousands of Acres for New Farms

By R. G. SKERRETT

STILL more fruits, still more fresh vegetables, will soon be shipped from Florida's sunny lands for the winter table. Millions will be benefited; for that reason, if for no other, special interest is attached to what the Government has been doing of late to put agriculture in the mysterious Everglades of that state upon a far firmer footing than heretofore.

The measures taken by the Federal authorities are intended first to hold within bounds and then to guide seaward, in definite channels, the flood waters resulting from the heavy rainfall of the average wet season in Florida and, besides, to rear barriers that can be counted upon to lessen the ravages of the hurricanes that sweep with varying severity across the state practically every fall.

This truly gigantic problem was given the Corps of Engineers of the United States Army to solve seven years ago. The defenses that those experts have devised and directed in the construction are now approaching completion. When finished, they will represent outlays aggregating close to 17,500,000 dollars. The key feature of the entire undertaking is the control of Lake Okeechobee, the second largest body of fresh water lying wholly within our boundaries.

That lake, roughly circular in outline, has an average diameter of 30 miles. Its surface area, with the water at normal stage, is fully 725 square miles. Where the lake is deepest, the bottom is at sea level, and at that point the water is 15 feet deep when the surface of the lake is where the engineers would like to hold it. Large parts of the lake are very much shallower; even so, because of its immense expanse, the lake can retain a tremendous volume of water when the surface is raised only three feet.

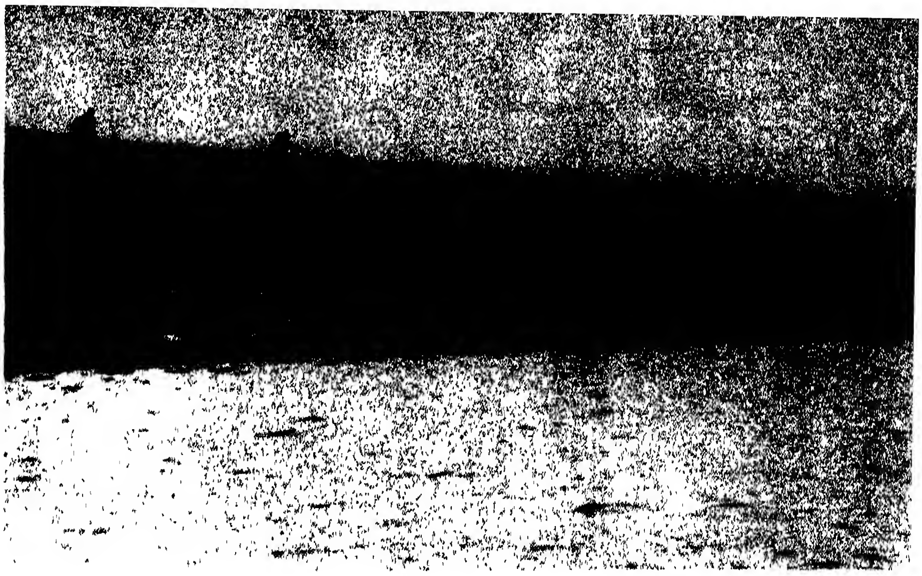
BEFORE the state started the drainage of the Everglades, flood waters could flow over the lower lip of the lake. Such overflow recurrently submerged far-flung areas of the Everglades until the water could make its way slowly to the sea over the nearly level intervening territory. The rainfall in southern Florida in the course of a year may vary from 45 inches to 65 inches, mainly within a span of four or five months—a tremendous amount of water either to be absorbed by the soil or moved onward to the sea.

Lake Okeechobee is the natural catchbasin for the run-off of an area of 4200 square miles lying to the north of it; an area of several hundred miles, directly south of the lake, slopes sufficiently toward the lake to lead excess precipitation into the lake. The state engineers, and consulting engineers to whom Florida also turned for guidance, promptly recognized that the Everglades could not be reclaimed unless the water pouring into Lake Okeechobee in the wet season could be led away to the sea in definite channels that would serve the twofold purpose of controlling the flood stages of the lake and of providing outlets for the surplus rain falling on the low lands of the Everglades themselves. Up to 10 years ago, Florida had spent, all told, nearly 18,000,000 dollars in digging four main drainage canals running eastward from Lake Okeechobee to the Atlantic seaboard; in excavating the Saint Lucie

Canal, also reaching to the Atlantic; and in rearing levees along the southern rim of Lake Okeechobee to confine flood waters that would otherwise submerge extensive areas of reclaimed and cultivated land.

The Saint Lucie Canal has served as the main safety valve in carrying flood waters from the lake to the sea, while the four drainage canals have functioned principally to carry off the rain-water reaching them from the flanking Everglades—not the lake. In the dry season, they served as arteries to deliver to secondary canals water drawn from the lake to provide irrigation. As a further aid in getting rid of the waters pouring into Lake Okeechobee in especially wet seasons, the state dug a second flood-control canal leading from the southwest side of Lake Okeechobee to a connection with the Caloosahatchee River, and thence onward to the Gulf of Mexico. The situation seemed a promising one until September, 1926, when a hurricane swept across the southern section of Lake Okeechobee, from east to west. The high winds, with a velocity of more than 125 miles an hour, drove before them a wall of angry water seven feet higher than the lake surface had been just before the storm arrived. That surging, irresistible mass launched itself against the earthen levees standing in its path, battered and breached them, and spread the lake, swollen by the heavy rainfall, loose upon the outlying lands.

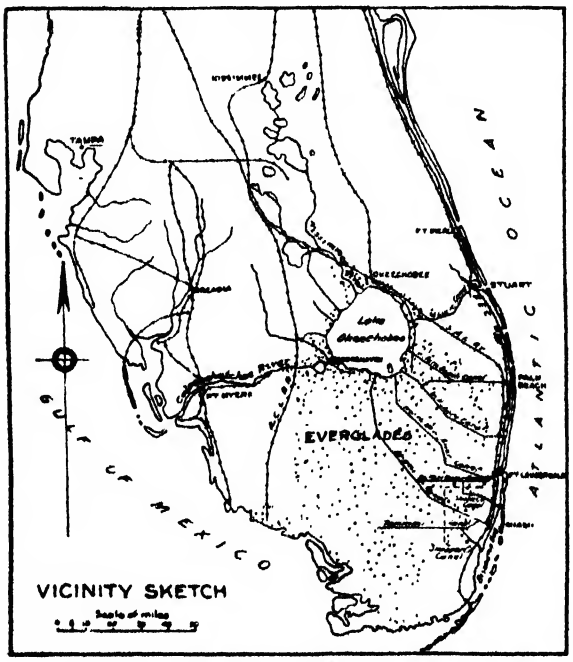
IN September, two years later, another hurricane hit Lake Okeechobee, traveling from southeast to northwest, the winds attaining a maximum velocity of more than 135 miles an hour. The north shore and the south shore, alternately, felt the full force of the cyclonic winds



which blew before them a turbulent body of water 12 feet higher than the general level of the lake. That storm destroyed property to the value of more than 3,000,000 dollars and took the lives of 2000 persons. Again levees were overtopped by the pounding waves.

Such was the state of affairs when the Federal Government came to the rescue in 1930 and began to plan permanent relief measures that would keep Lake Okeechobee's waters confined even if a hurricane of record violence should again blow across the region. To achieve this, the Army engineers designed, and have since erected, levees considerably higher than previously built there, and so broad and firmly established that they can resist the pounding of hurricane waves and hold their crests safely above the storm-driven waters.

The levees rise to an average of 20 feet above the ground at the shore level; are more than 200 feet wide at the base; and slope thence to their crests where their flat tops are from 15 to 30 feet wide. Dredging and placing of material required in erecting the dikes has involved the handling of millions and millions of cubic yards of sand, gravel, shell, and rock—not to mention the job of clearing away immense quantities of overlying muck unfit for construction purposes.

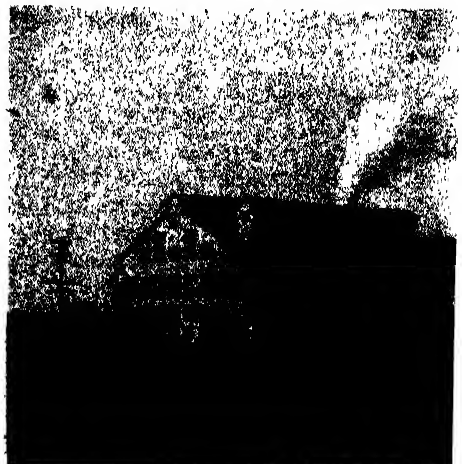


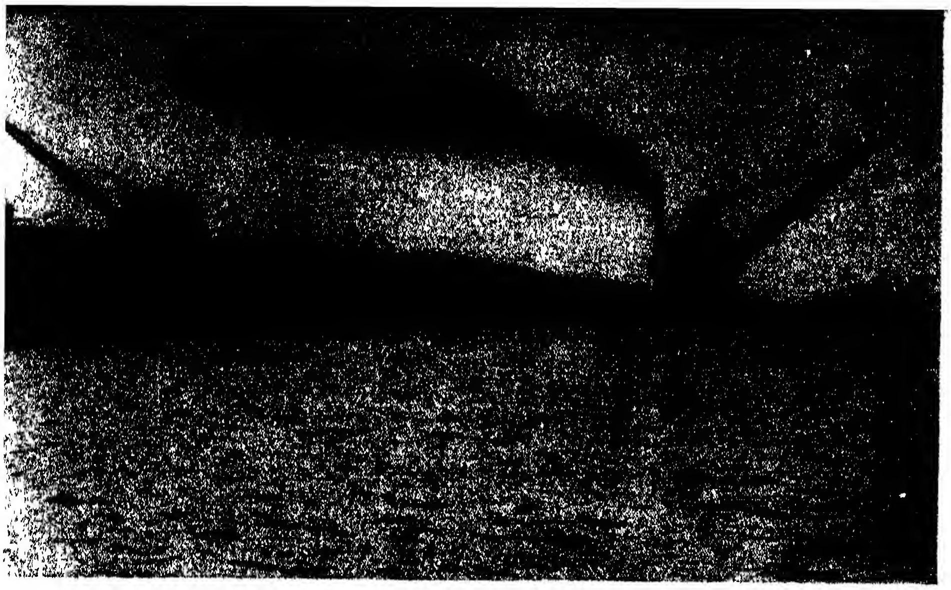
The tip of the state of Florida, showing the vast area of the low-lying, swampy Everglades

In digging or otherwise excavating the materials used in rearing the 80-odd miles of levees—68 of which encompass the southern half of the lake—the dredges have incidentally cleared a navigation channel paralleling the southern line of levees. This channel has a controlling depth of eight feet and a surface width of 80 feet at the normal stage of the lake. The channel is protected on its lake side by a dike formed of some of the material excavated during the progress of the work. This sheltered waterway gives access to the drainage canals that tap the lake and to the communities that have grown up on the land side of the southern levees.

Where each drainage canal meets the lake, the Army engineers have provided hurricane gates of steel which can be opened and closed either by electric motors or by hand. They are of a type that can be operated against a considerable head of water. In time of storm, they will be closed, and at other times they will be operated as required for the regulation of water or the passage of light-draft craft. At the lake entrance to the Saint Lucie Canal and at the corresponding entrance to the Caloosahatchee Canal have been built new navigation locks capable of accommodating larger vessels than in the past. Improved channels have been dug in the lake; and deeper water and a broader channel now link Lake Okeechobee with the Gulf of Mexico, via the Caloosahatchee River. The Saint Lucie Canal is likewise in process of being made fit for heavier traffic throughout its entire length of 24 miles. In short, Florida has nearly com-

Reclaimed Everglades land will feed sugar cane to mills such as this one, located at Clewiston, Florida

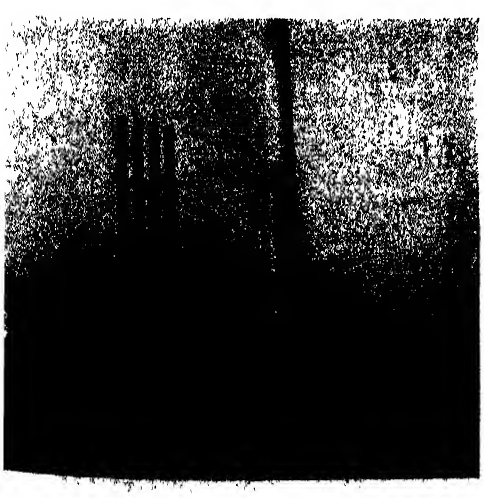




The great size of the levees on Lake Okeechobee may be noted here during finishing and dressing work

pleted a canal directly across its peninsula, between its Atlantic and Gulf coasts; and that waterway promises to be a boon to yachtsmen and a material aid in promoting further agricultural and industrial development of the whole adjacent territory.

In its improved condition, the Saint Lucie Canal will be able to receive from Lake Okeechobee, at flood stages, 5000 cubic feet of water per second and lead that water to the canal's junction with the Saint Lucie River, that discharges into the Atlantic. By dredging, straightening, and deepening the channel of the Caloosahatchee River, that stream will be counted upon to transport 2500 cubic feet of water per second from Lake Okeechobee to the Gulf of Mexico whenever that relief is needed. Lake Okeechobee, with 68 miles of new levees on its south shore and 15 miles of improved levees on its north shore, together with its more capacious control canals and better defended drainage canals, is now a skilfully balanced project and is equipped, as it was not before, to meet all probable conditions and to contribute to the safe and steadily widening reclamation of the Everglades.



The Everglades, which mainly lie below Lake Okeechobee, have an average east-and-west width of 40 miles and extend southward for 90 miles before reaching tidewater. They have an area of nearly 2,860,000 acres, of which something like 80 percent is said to be susceptible of drainage. The Everglades occupy a shallow limestone basin in which has been deposited, during untold thousands of years, an immense accumulation of rotted vegetal matter. That muck has a vertical thickness of two feet near its southern limits and is 12 feet deep adjacent to Lake Okeechobee. Where that black soil rises above the water in the form of low-lying humps or "hammocks," it has usually evidenced its natural fertility by the character and kind of its luxuriant plant life.

But there are vaster low-lying and almost dead-flat expanses that are covered with saw-grass, which is both difficult and painful to penetrate. The boggy soil from which saw-grass springs, even when drained, has generally required a number of years of cultivating to make it yield a marketable crop of any kind. The agricultural chemist discovered an answer to the puzzle: he found that a small quantity of copper sulfate and some other chemicals, when spread over each acre, would work an astonishing transformation. The soil so treated becomes almost immediately fit for planting and capable of producing abundant and profitable yields.

With a favoring climate, a wealth of sunshine, and the soil suitably drained, lands in the Everglades speed up germination and induce unusually rapid growth. Palm nuts, which ordinarily require from two to three months before sprouting, will, in the favoring soil of the Everglades, send their shoots above ground in two weeks. Beans and peanuts will break through the surface within two days after their seeds are planted; and it is said that cotton will ripen its bolls two months sooner than elsewhere in this country.

There are now thousands of acres of land in the Everglades upon which sugar cane is grown, and during the months of ripening as many as six harvests may be reaped. These cane fields yield as much as three tons of sugar per acre annually—an extraordinary production. This has been achieved through the sustained collaboration of experts of the United States Department of Agriculture and the leading cane growers and sugar producers in Florida.

About 30 years ago, when the state of Florida first began the systematic drainage of the Everglades, she sold the earlier of those lands for as little as $1.25 an acre. Since the great richness of the reclaimed lands has been proved by men skilled in agriculture, the value per acre has increased nearly a hundredfold in many sections. This fact is mentioned merely to illustrate that the lands of the Everglades, virtually unexplored to any comprehensive extent for generations and even until within the last three decades commonly classed as well-nigh worthless, are now coming into their own because of their inherent fertility and the betterments brought about by the engineer and modern mechanical aids.

With Lake Okeechobee held within bounds by the defenses reared by the Army engineers, and with ampler channels provided for the prompt escape seaward of the very heavy seasonal rainfalls, the Everglades assume a new economic position in the nation, and from now on can be counted upon increasingly to supply tens of millions of us with luscious fruits and fresh vegetables when such commodities are most needed and not to be had from nearer sources.

"Withal it [the Everglades] is a strange country, a land of anomalies and the grotesque. Here fish sing (on the reef small fish attach themselves to the hull of a boat after dark and give off their plaintive notes all night long); snakes often live in trees; epiphytes grow as terrestrials; terrestrials grow as epiphytes; giant oak trees are arbours for aerial plants and ferns; cacti grow in water; oysters grow on trees that dip into the creeks; large pine trees and broad-leaved trees grow on rocks lacking soil; fig-trees grow as petriphytes trying to strangle the rocks; giant palms more than a hundred feet tall and cactus trees 30 feet tall grow as humus-plants; strangler figs kill other trees, and often turn upon themselves and commit suicide."—From "The Proposed Everglades National Park," by Dr. John Kunkel Small, New York Botanical Garden, in *Nature* (London).

ESP

What Precautions are Being Taken to Forefend Against Error in the Extra-Sensory Perception Research as Conducted at the Duke University?

By PROF. J. B. RHINE
Parapsychology Laboratory, Duke University

ONE of the leading problems in the scientific news at the moment is ESP, or extra-sensory perception, the current technical name for telepathy and clairvoyance. This work was given some of its present impetus by the publication in 1934 of my book, "Extra-Sensory Perception." So misleading, however, have been some of the recent references to this research that I am compelled to accept this opportunity to clarify certain essential points.

The ESP research [July 1934 and July 1935, Scientific American.—Editor.] was started to test the assumption that nothing can enter the mind except through the channels of sense (that is, vision, hearing, taste, and so on). In order to investigate this assumption, my associates and I, as well as many other university experimenters, have tested many hundreds of normal people to discover whether they can perceive things (that is, know about them) without any sensory contact via the known senses.

The tests are simple, consisting of naming cards in an inverted pack. In the more advanced tests in use for some time the cards are held out of sight and beyond the reach of the person calling them. If the subject can get more cards right than chance allows, this would give evidence of a way of perceiving which is beyond the senses—extra-sensory—in short, ESP. And according to the now numerous published reports from well beyond a dozen college laboratories, that is what happens in most of the ESP experiments to date. The results are better than chance by tremendous odds.

AS a natural result of such unorthodox results, the work in ESP has brought about a great deal of discussion, pro and con. The first battle line on this scientific front formed on the question of whether the results were really due to an extra-chance factor—whether the mathematical basis of the results is secure. Several of my fellow-psychologists (Drs. R. R. Willoughby of Brown, C. E. Kellogg of McGill, Dael Wolfle and H. O. Gulliksen of Chicago, and C. P. and J. H. Heinlein of Florida State College for Women) have criticized the mathematical methods used in the ESP work.

Leading authorities in the field of mathematics, however, have approved the statistics and its application. In the English edition of "Extra-Sensory Perception" I quote a letter from Prof. R. A. Fisher of London University approving the mathematics used, and a pronouncement made within recent months by the President of the Institute of Mathematical Statistics, Prof. Burton H. Camp of Wesleyan University, stated:

"Dr. Rhine's investigations have two aspects: experimental and statistical. On the experimental side, mathematicians of course have nothing to say. On the statistical side, however, recent mathematical work has established the fact that, assuming that the experiments have been properly performed, the statistical analysis is essentially valid. If the Rhine investigation is to be fairly attacked, it must be on other than mathematical grounds."

Prof. E. V. Huntington, of the Harvard Department of Mathematics, has submitted tables for evaluating the results of the card tests which still agree closely with those previously in use. It appears clear, then, that the mathematical and statistical verdict is in favor of the ESP investigators.

But the critics, failing in their attack on the mathematics, are already looking for another possible point of attack. If the results are not due to chance, they are saying, then "sensory cues" from the cards may account for the success. The person calling the cards, it is charged, may get cues from the back of the card, from shiny table tops, or from the feel of the cards as he handles them. Perhaps even the experimenter involuntarily makes faint noises that guide the calling.

What do the people investigating ESP say to these criticisms? That obviously these have been the very dangers which from the outset the research was planned to avoid. How the investigators did it has been repeatedly described in articles in the *Journal of Parapsychology*, the publication reporting current experimental work in this field.

From the very beginning, precautions against sensory cues were carefully used. Shiny table tops were avoided, cards were hand-stamped and inspected. They were called before being touched or even right down through the pack, and in the main block of the research not even the experimenter knew the card to be called and hence could give no involuntary cues to the subject.

Even so, in the articles referred to above, all tests where the subject could as much as see the backs or edges of the cards, or even touch the unseen cards, were set aside. The survey includes only those trials in which there was no sensory contact with the cards, and all of these trials, high or low in score, are included in the report.

Thus narrowed down, the evidence for ESP consisted of tests either at a distance with walls between subject and cards, or of tests with opaque screens set up which shielded the cards from the subject's sight and touch, or of tests with each card sealed in an opaque envelope. These last were used even with blind subjects.

BUT even when restricted to such cue-proof conditions, there remain 142,825 trials by 118 subjects working under the observation of ten different experimenters, six of whom are or have been college instructors in psychology. Four laboratories—Columbia University, University of Colorado, Tarkio College, and Duke University—contributed to the results involved in this survey.

These 142,825 trials (which include all the work, good and bad scores alike, which was done under the rigid testing conditions described) gave an average of 5.8 hits per 25 calls as against a mean chance expectation of 5.0. The odds are 10^{195} to 1 that so large an average score for so many trials would occur by mere chance—odds so great that it would take 196 digits to write out the figure! Thus the most rigidly guarded conditions yield results that incontestably indicate that something more than chance occurs in the ESP tests.

If the senses are barred, as the conditions would appear to require, either there is some error yet to be uncovered in this pioneer research now being conducted in more than a score of American colleges or else extra-sensory perception must be added to the range of known mental abilities. One should not and need not believe or disbelieve in ESP, as it stands today; he should, if he is able, undertake to assist in finding out more about the question, preferably through laboratory research itself. The research, its worst critics will concede, deserves careful consideration and repetition.—*Science Service.*

OUR POINT OF VIEW

Five-Year Patents?

INVENTION has its birth in a number of stimuli. The desire for glory, for prestige, for the satisfaction of the ego, are rather important causes of invention, but by far the greatest incentive to progress through invention is that of profit. Except for a few seekers after knowledge in the abstract, a few others urged on by scientific curiosity, and a few accidental discoverers of a new principle or device, inventors are impelled primarily by the profit motive. And progress, for the general good of all, is the worthwhile result.

Now Congressman McFarlane would make the inventor the loser by reducing the possibility of profit. He recently submitted a bill to make compulsory the licensing of any patent after three years instead of giving the inventor an exclusive right to his brain-child for the traditional 17 years. He has since withdrawn that bill and substituted one which would make the licensing of a new invention compulsory after five years if the patent has not been developed in that time, if the patent owner cannot meet the demand for his product, or if he charges an "excessive price."

The thought behind this tinkering with the present highly successful patent law is to force immediate commercial production of every new invention, whether or not the time is propitious. An individual or a company may spend hundreds or even thousands of dollars in the development of, for example, a new machine. Having patented several "editions" of that machine, the inventor finally starts production with his last, most efficient machine. His preceding patents are undeveloped, unused. After five years, a competitor steps in, demands a license to commercialize the unused patents, and starts production. It is conceivable that the competitor comes into the market at the "propitious time" to build a competing business that may drive the owner of the patents out of production entirely (though paying royalty to the owner). Again, since values of an invention are often intangible, a competitor may show that the original patentee is charging an excessive price for his product and thus obtain a license to compete with him, using his own invention.

The comment which Dr. Charles L. Parsons, secretary of the American Chemical Society, made in regard to the three-year bill—that three-year patents would be valueless—applies equally to the five-year bill. Indeed, that conclusion is inescapable when one examines the facts with an unbiased mind. Such a patent law would exert little control over "monopolistic trusts" (as so many corporations are now dubbed by spellbinders, and against which the bill is aimed) but would definitely slow up the larger progress which is now being made by scientists, engineers, researchers who hope to have a patent to sell in return for their labors.—*F. D. M.*

Scientific Method versus Prejudice

WHEN Prof. J. B. Rhine at Duke University set out to reduce the previous looseness of the so-called psychic "science" of earlier periods to a laboratory procedure under controlled and reproducible conditions, he at first limited himself to two special aspects of it—telepathy, the perception of the mental activities of another person by other means than the normal senses, and clairvoyance, the perception of objective events by similar means.

Now, for the first time, Prof. Rhine reveals the preliminary findings of a third and allied kind of research which it appears has quietly been undergoing tests at Duke since 1933: precognition or foreknowledge. How can this question be tested scientifically?

Certainly we cannot test it by citing striking experiences such as most of us have had. No matter how strongly those experiences convince the individual, they cannot be switched to others in the form of proof. They are too indefinite, too intangible, too vaguely bounded to reduce to anything like a common denominator between minds; and they may be nothing but beautiful coincidences, anyway. Therefore Rhine tests precognition by the same ESP cards used before in testing telepathy and clairvoyance, but with an added kink. With clairvoyance it has proved possible to "call" or name more cards than probability calls for, when a pack of 25 cards is laid face down and the subject is asked to identify each card down through the pack, without removing any. Suppose now there were such a thing as precognition. Then, if the subject were asked to do the same thing, but to name the cards in the sequence they would take *after being shuffled* at the end, precognition of future events would seem to be shown if the subject was able to name more cards than probability called for. This is what has happened. In an extended series involving 113,075 trials and 49 subjects the scores were better than probability in the ratio of 400,000 to one. Coincidence, or what?

As yet Prof. Rhine regards these findings as tentative; far more work remains to be done. Unfortunately, many persons are judging the tests at Duke on the basis of inclination, preconception, or what-not, when open-mindedness—neither incredulity nor credulity—seems to be called for. Nothing short of such an attitude is scientific.—*A. G. I.*

Training

TRAFFIC court is an excellent place to find out various things about the competence of automobile drivers. In a recent survey by Dr. Lowell S. Selling, Director of the Psychopathic Clinic of the Recorder's Court in Detroit, it was found that not one out of a hundred drivers who had been brought into court for various traffic violations had learned how to drive his car with confidence, tactfulness, and a thought for the other driver. Such investigations as this are of great value in guiding the thoughts of those who are directly and indirectly responsible for safety on the highway. Dr. Selling has found, for example, that many of the drivers involved in traffic offenses are insane; many are feeble-minded; many are illiterate; many, of course, are relatively normal but have never been properly trained in motor-car driving.

More and more is going to be heard in the future about adequate training of drivers. Such training will eventually and automatically weed out the insane, the feeble-minded, and the dangerous illiterate; it will make possible a revision of the thought processes of those normal human beings who aspire to safe driving, rendering them competent to drive a motor car with a maximum of safety to themselves and to others.

Such training must be carried out on a grand scale and must be thought of as a permanent institution that will eventually—within not less than a generation—make every motor-car driver aware of his responsibilities and fully able to cope with them under all ordinary as well as emergency circumstances.

Driver training is undoubtedly the only answer to the most important phase of the motor vehicle safety problem. What form it will eventually take we cannot venture to say here. But everyone concerned with highway safety is going to hear a lot about it in the very near future; thoughts will eventually crystallize into action and then something definite will be done about the whole pressing question.—*A. P. P.*

But Can You Eat Onions?

Non-Allergic Food Sensitivities . . . How to Trace Down Dietary Idiosyncrasies Scientifically . . . A Lady Who was Suffering Mainly from Fox's Disease

By T. SWANN HARDING

THE scene is a doctor's office. The patient under examination complains of periodic headaches with a general feeling of exhaustion and muddle-headedness between. The doctor asks:

"Is there any food you can't eat?"

"No. I can eat absolutely anything eatable."

"How about cucumbers?"

"Well, I can't eat them. But then, most people can't."

"How about milk?"

"Never touch it."

"Why?"

"It used to make me sick when I was a kid."

"What about eggs?"

"O, they make me awful sick every time!"

"Can you eat an egg custard?"

"Yes, I can, and I can take eggnog, and I can eat hard-boiled eggs all right. But it always makes me sick to see any soft, uncooked egg white."

Naturally the patient had trouble with onions, too.

This scene is characteristic. Certain more alert doctors are going at this diet business in a new way. The old way was to pick out the things the patient liked, tell him not to eat them, and call the rest a diet. The old way was to tell the patient what to eat. The new way is to find out experimentally what foods he can eat with comfort and safety.

FOR many long years certain individuals have known they could not eat shellfish or strawberries without getting hives, or eggs without getting headache, asthma, or hay fever. It is now known that these troubles are often due first to some peculiar sensitiveness of the individual, and second, to the entrance of a little undigested food, and particularly protein, into the blood. Medical men call these disturbances "allergic" in nature, the type due to foods being called "food allergy." An entire medical specialty is now devoted to finding allergic causes for asthma, hay fever, indigestion, flatulence, sick headaches, certain skin eruptions, and other troubles.

The medical specialists so concerned are called allergists. They first tried to identify offending foods by means of skin tests. A little scratch was made on the skin and a droplet of a solution of the food to be tested was put on it. In cases of sensitivity a big hive soon appeared at the spot. While these tests often helped in finding the cause of asthma or hay fever, they have not proved very useful in locating the causes of indigestion, flatulence, and general malaise. It seems that the skin is more closely related to the inside of the nose and lungs than to the digestive tract.

Too much deduction has been made from the diet of laboratory rats

Today many allergists admit that skin tests are of little value when it comes to finding foods that cause indigestion. Dr. Walter C. Alvarez, of the Mayo Clinic, goes so far as to say that often they are a nuisance because when once patients find that their skin is sensitive to certain foods they are forever after afraid to eat them, and sometimes they are reduced to skin and bones as a result of unnecessary starvation. No one should ever go without a food simply because his skin reacts to it. He should test it and see whether eating it actually causes distress.

Among the leading pioneers who have been waking up the medical profession to the importance of sensitiveness may be mentioned Dr. Alvarez, Dr. Albert Rowe, and Dr. Warren Vaughan.

Incidentally, not all food-sensitiveness is allergic. As Alvarez has pointed out, such things as pepper, mustard, and alcohol may simply irritate the digestive tract, and onions, cucumbers, melons, dried beans, and tomatoes probably contain small quantities of drug-like substances which produce regurgitation, belching, and flatulence. This may well account for the fact that many of the annoying disturbances produced by eating certain foods are not diagnosable by skin tests.

THERE is the case of a doctor who could eat onions without difficulty if they were first soaked in vinegar, but who had an attack of asthma every time he ate them otherwise, raw or cooked. This suggested that some chemical irritant was washed out or altered by the acid vinegar. Another person maintained that cucumbers with the rind on were harmless to him, whereas peeled cucumbers gave him distress. Still another found that the harmful part of an apple was in its peelings.

Many cases were found in which symptoms suggesting gastric ulcer were caused by eating banana, apple, cabbage, turnips, or meat, or drinking milk, alone or in combination. In one instance appendicitis was simulated when onions were eaten. Many persons complained of canker sores in their mouths after eating certain foods.

A certain man who each morning fought off an almost irresistible tendency to go to sleep found with his doctor's help that this was due to the cream in his coffee. Severe hunger pains, usually considered typical of stomach ulcer, have also disappeared in a few cases when milk, chocolate, or orange juice was banished from the diet.

An interesting case was that of a young man who suffered from a sort of mental cloudiness that prevented him from working. In spite of treatment by many doctors the condition persisted. He was dull, listless, apathetic, and bothered by a variety of abdominal pains and distresses. Yet, when he was given a diet composed only of foods that rarely distress anyone, his head cleared and his ambition returned in 48 hours. Subsequently he gained in weight on a somewhat more extensive diet and returned to work.

Often two factors combine to cause the trouble. Thus a certain woman could eat wheat in winter but had to avoid it in summer in order to avoid hay fever. Another individual became wheezy on exercising only if he was eating wheat. Fatigue, nervousness, mental strain, worry, and so forth may make an individual sensitive to certain foods that he can eat freely without difficulty when at his best.

The symptoms caused by this non-allergic food sensitivity are most often the following: A hay-fever type of stuffy nose; indigestion; flatulence; abdominal pain; and, occasionally, diarrhea, hives, headache, stupid feelings in the head, canker sores, but much more rarely irritations of the joints and bladder.

STUDENTS of nutrition and even doctors have long concerned themselves with the mineral, vitamin, and caloric content of foods and the biological value of their proteins. But the digestibility of various foods has been neglected. Doctors have tended to follow dietitians in this neglect. Yet the digestibility of a food is extremely important. It may bulk larger at times than its content of vitamin A, calcium, iron, or complete protein.

So far, most of the books on dietetics either ignore the subject of digestibility or else dismiss it with a few words as of minor importance. Unless a dietitian has been especially trained under an allergist she is likely to have little patience with those who claim they cannot take milk, eggs, orange juice, or spinach. Patients in and outside of hospitals are often forced to eat so-called "health foods" even after they have explained that they could not tolerate them after childhood.

The average physician, when asked for advice on diet, warns usually against fried, greasy, or "rich" foods, or against those foods which he himself finds it difficult to handle. He may recommend others he likes. He may give the patient a printed diet list that will fit that individual's needs about as well as the key to one safety deposit box fits the lock of another. If the patient protests against eating foods that are considered good for him he gets scant sympathy. He may be told he is unco-operative, or that the trouble is in his head. He may be impatiently ordered to do as directed. Yet the doctor's dietary advice, like that of the hospital dietitian, is built around the big idea of the nutrition scientist; that is, to supply all patients every day a diet complete enough to ensure good growth and ultimate reproduction in a baby rat.

Of all the fruits and vegetables, onions appear to be a common offender

For this reason the physicians abovementioned began a while back to query patients about what foods they could safely eat. As was indicated by the dialog at the beginning of this article, this inquiry must be carried on with skill, for many of us think we can eat anything, until we are questioned closely or our memories are refreshed by reading a list of foods. The results of these inquiries are interesting and of much importance.

Dr. Alvarez found that the following foods produced more or less distress in 10 to 28 percent of 500 persons questioned, the foods being listed in descending order of frequency: Onions (usually raw); milk, cream, or ice cream; apples (raw); cabbage (cooked); chocolate; radishes; tomatoes (more often raw); cucumbers; eggs; fats, greasy, and "rich" foods; cantaloup; meat or beef; strawberries; coffee. Among the foods that very seldom offended were: lamb, gelatine, butter, sugar, rice, barley, arrowroot, carrots, asparagus, turnips, peas, beets, squash and canned pears.

Chocolate is a very common and often a serious offender, yet how many avoid tea and coffee to drink chocolate or cocoa! Pie and pastry, which have such bad reputations, were rarely complained about. The commonly despised fat and greasy foods were blamed by many, but this, as was also true in case of onions, is often due to the fact that they happen to be tasted when belching. Hence they are blamed at times for the sins of other foods.

If the food is one that is rather rarely eaten—like crabs or strawberries—the patient easily spots its effects, but if it is one that is eaten at nearly every meal he may go on suffering mild distress for years without ever realizing that the offending food is wheat or milk. Hence, rarely used foods are doubtlessly more often cited in such lists as the above, though certain commoner foods may be more distressing. In some cases, of course, the aversion is purely psychic and due to some unfortunate association.

THERE is now pretty general agreement among a number of investigators that wheat, eggs, milk, chocolate, cabbage, onions, tomatoes, and oranges frequently offend. Yet these are such foods as are eaten daily by most of us. Moreover, it takes an unusual person to discover without expert assistance that his breakfast coffee or the toast that goes with it is responsible for such mild but efficiency-reducing symptoms as flatulence or a stuffy head.

As to the kind of symptoms produced —onions, cabbage, apples, radishes, dried beans, cucumbers, and milk were usually accused of causing gas, belching, or distention. Onions, radishes, cantaloups, cucumbers, lettuce, fats, and melons generally produced regurgitation, a lingering taste, or "repeating."

Migraine was most often caused by onions, milk, peanuts, cabbage, eggs, pork, apples, coffee, oranges, and cucumbers. Vomiting, severe pains, and diarrhea were most frequently caused by milk and its products, chocolate, raw apples, raw onions, eggs, tomatoes, cooked cabbage, and certain meats. So much for samplings made among people who are sick enough to see a doctor yet who do not complain of stomach or intestinal trouble.

Dr. Osee Hughes, on the other hand, interviewed about a thousand individuals in good health, at Ohio State University. Her results tended to confirm those of Dr. Alvarez. The symptoms mentioned by those who were queried were very similar to those already listed here. There were, however, some differences in the relative standings of individual

foods, as stated by the different persons.

The foods that most commonly disagreed with healthy young women were, in descending order of frequency: onions (raw), radishes, cabbage (cooked), beans, cucumbers, onions (cooked), tomatoes (raw), greasy or fried food, frankfurters, bananas, strawberries, eggs, and chocolate. Apples and milk, which stood high on the list of Dr. Alvarez, had rather a low standing.

THE foods that most commonly disagreed with healthy men and women between 30 and 65 years of age were, also in descending order of frequency: onions (raw), cabbage (cooked), beans, greasy foods, cucumbers, peppers (raw), sauerkraut, "sweets," pork, chocolate, milk, tomatoes (cooked), onions (cooked), bananas, radishes, and seafoods. In general, people did not avoid foods that mildly disagreed with them but often ate them regularly.

Raw onions and cooked cabbage stand high as offenders on all lists. Frankfurters probably assumed a prominent place in the lists derived from the young women because they were college girls who frequently went on picnics and wiener roasts. The older group of healthy people found milk more difficult to handle than did the young women.

But what can be done about this? Is there no way out? As was mentioned earlier, there are certain foods which rarely offend. Therefore it is possible to devise a diet on which a person's nutrition can be maintained temporarily, using foods that rarely offend. This is called an elimination diet. Once one is found that works perfectly, other foods can gradually be added, one after the other, till all offenders have been spotted and the ultimate diet is as diverse and rich as the particular individual can stand.

Putting a person on an elimination diet may not only reveal that he or she is sensitive to one or more foods; in many cases it promptly demonstrates that he or she has neither sense nor intestinal fortitude. In other words, a fussbudget with too many strong likes and dislikes is unmasked.

For instance, a woman with a facial rash declared she had been all over the world seeking successful treatment but got no relief. She declared also that she would do anything to be cured. The doctor told her that the trouble was due to eating some food to which she was sensitive. In order to identify the food he told her to go for four or five days on an elimination diet of nothing but lamb, rice, potatoes, butter, sugar, and Jello.

Immediately she began to complain bitterly that she could not do without her morning coffee; that she didn't like rice and didn't like Jello; that she must have ice cream now and then and a cocktail before dinner. After much grumbling she said she would *try* to adhere to the diet, but the next day the doctor saw her getting outside of a large chocolate ice cream soda. His diagnosis of this case was Fox's disease.

To those who are unfamiliar with this technical term it should be explained that it was named after an interne who was himself named Fox. He was asked by his chief what he thought was the matter with a woman upon whose case he had been working. He replied to this effect: "Well, doctor, it looks to me as if she was just a plain damned fool!" Hence this condition, rather frequently met with, came to be known as Fox's disease.

Counting the bacteria in seafood, but some are sensitive to seafood even when it contains no bacteria

Many people are quite familiar with one or two of their own dietary idiosyncrasies. But other such weaknesses must be unmasked by an expert. If the indigestion or pain or migraine occurs at intervals of weeks or months, the cause can often be found by making a written record of all unusual foods, not eaten every day, consumed in the 24 hours preceding the upset. Suspicion should rest heaviest upon foods eaten at the preceding meal, as distress usually follows quickly.

After three or four attacks an examination of the written list may enable the patient to identify the offending food. If relief is obtained upon letting it alone much will have been gained. But the food should be further tested by eating it again to make sure it is responsible for the attacks in question. If the result is positive the food should thereafter be avoided. Lists of foods eaten during periods when the patient is comfortable will aid in guiding him as to what to eat.

If the distress be present after almost every meal the problem of finding the offending food must be simplified, perhaps by actual fasting for a short time. Should the distress continue, food obviously could not be the cause. If it ceases, then the patient can be given a new food daily until the offenders are spotted. Good foods can then be kept on the dietary list and the bad ones discarded. Since some patients haven't the hardihood to fast the elimination diet often comes in handy.

The diet most commonly used by Alvarez consists of *nothing but* lamb, rice, butter, sugar, and canned pears. For breakfast the patient may have a lamb chop with puffed rice or rice flakes, or steamed rice with butter and sugar, or some syrup from the can of pears. Cooked rice can also be made into little cakes and fried in butter. No pepper and sauces; no onions—the meat being either roasted or else fried in butter, and no other fat. The only drink is water.

For luncheon the patient may have a chop or a piece of roast lamb, again with rice and canned pears. Dinner is a reproduction of luncheon—eaten backward if desired, or off the mantel shelf. Obviously no coffee or tea or soda fountain drinks, or candy or even chewing gum, is allowable. Any added substance put into the mouth complicates the problem. No laxatives or purgatives should be taken.

If the distress was due to a harmful food its symptoms usually are gone within 12 hours. Whether they clear up or remain, the elimination diet should be continued another day to make sure. If by then they have disappeared the patient can add a new food daily to his elimination diet, keeping a full record, and finally avoiding all foods that give distress.

In order to avoid upsets at the start, with discouragement and possible weight loss, foods not high in the list of trouble makers should be tested first, such as beef, potato, gelatin, carrots, turnips, asparagus, string beans, arrowroot cookies, thin toast, and oatmeal, possibly in that order. Later, when the patient has gained confidence and has found a fairly liberal diet that he can handle, he can try the more notorious trouble-makers. Then he can make a stab at eating onions.

IF trouble persists on the elimination diet, then either the patient's symptoms are not due to foods or else he is sensitive to one of the foods like lamb, rice, sugar, butter, and pears. By subsisting for a couple of days on pure maple sugar the latter possibility can be tested out. If the distress still persists it is unlikely that further dieting will help.

Sometimes the patient will find after a few months at home that he can safely eat certain foods which formerly upset him. He should therefore constantly experiment among the forbidden foods and broaden his diet if he can. He should strive ever to return to a normal diet. No one should ever remain for weeks or months on a highly restricted elimination diet, as this is used for diagnosis, not for extended treatment.

UNCONVENTIONAL AQUARIA

ONE of the most ambitious efforts to reproduce ocean life is nearing completion at Marineland, Florida, which is located on the new Ocean Shore Boulevard 35 miles north of Daytona Beach and 18 miles south of St. Augustine. Consisting of the two largest aquaria ever built, which are also the world's only specially designed underwater motion picture studios, these Marine Studios will afford visitors and scientists an unusual opportunity to observe and photograph large and small fish and aquatic mammals much as they are found in their natural surroundings under conditions duplicated nowhere else in the world.

Conceived several years ago and representing an investment of approximately $500,000, Marine Studios has been developed by W. Douglas Burden, an associate of the American Museum of Natural History, Ilia A. Tolstoy, grandson of Count Leo Tolstoy the famous Russian writer, and Miss Lillian Koehler, an associate of Mr. Burden. After much patient pioneering work, they have developed a wholly new principle of presenting the strange, beautiful creatures of the sea. Instead of displaying each species in its own segregated compartment, a more natural presentation of submarine life is offered in both of the huge tanks where each species plays the same part that it does in the open ocean.

The unconventional features of the design, which afford visitors to Marine Studios a unique opportunity to study and photograph marine life, center around the construction of the tanks themselves.

Artist's conception of Marine Studios, the two largest aquaria in the world and the only ones ever to be designed as under-water motion picture studios

One is polygonal, and is 100 feet long, 40 feet wide, and 18 feet deep; the other is circular, 75 feet in diameter and 11 feet deep.

Enclosed galleries run at different levels around the entire perimeters of the two tanks. Each of the galleries faces inward upon a circle of glass portholes, of which there are over 200 in the sides and bottoms of the inner tanks where the marine life is displayed. The portholes are placed in such a way as to make it possible for observers to look into the tanks from four different levels.

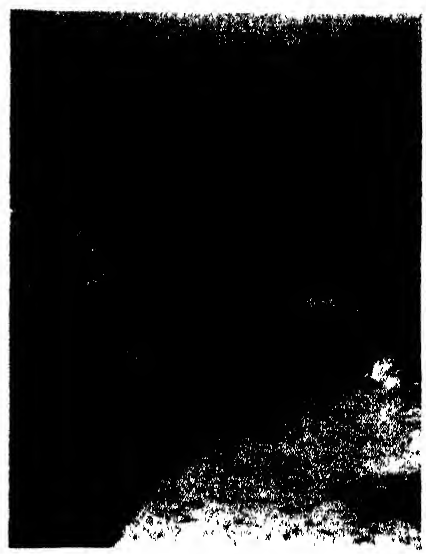
A 235-pound loggerhead turtle as seen through one of the portholes 12 feet below the water surface. Amateurs may make such pictures

THE design of the tanks was recommended by Fred Waller, President of Courier Productions, Inc., and other technical motion picture experts who worked out in advance the various camera angles that would be necessary to afford producers the greatest latitude and leeway in the filming of scenes. These angles were the controlling factors that actually determined the shape and dimensions of the tanks and the location of the glass portholes.

This enterprise hopes to give the spectator a dramatic, vivid, fascinating cross-section of life in the sea. Already several porpoises, believed to be the only ones alive in captivity, sharks, loggerhead turtles, and penguins have been assembled, in addition to several tons of coral reefs around which some of the smaller and more beautiful creatures of the sea are making their home.

By extensive research, Mr. Tolstoy has developed, with the assistance of Dr. G. Kingsley Noble, of the American Museum of Natural History, a drug which, when injected into large sharks or similar creatures of the sea, puts them to sleep almost instantaneously, yet the effect is temporary, leaving no after effects. While under the influence of this drug, they can be transported and placed in the huge aquaria without injury to themselves or to anyone else.

"Our idea," says Mr. Burden, President of Marine Studios, "is to build something which is sound and of lasting value, of value to the public, of value to the community in which we are located, and of value to science."



Coral gardens on the floor of the aquarium. The water is extremely clear. Sunlight entering from above shows portholes at different levels

HOME NEWSPAPERS BY RADIO

Your Home a Silent "Press Room" . . . Automatic Facsimile Reproduction . . . Latest News by Breakfast Time . . . Bulletins Are Now Being Broadcast

A PRIVATE newspaper with any spot in your home as the press room, the world's best editors and reporters on your staff, is available today to anyone in the United States possessing an ordinary radio receiving set. No thundering press will deafen you while your newspaper is being printed; instead, equipment contained in a small attractive box will silently print your "latest edition" while you sleep, completing it in time for reading at breakfast.

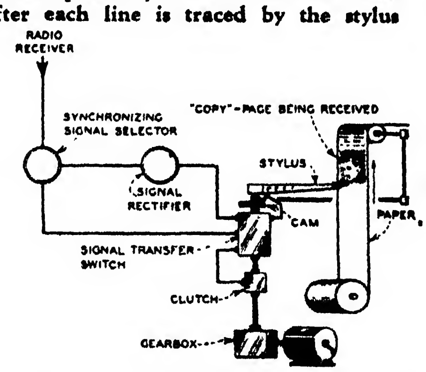
The name of this service now available is facsimile, first cousin of television since it shares with it some of the same basic principles. Unlike its more glamorous and well publicized relation, facsimile steps into broadcasting from other communication fields in which it already has proved its capabilities in a quiet but exceedingly effective manner. Facsimile has been in daily commercial use for several years, speeding news-photographs back and forth across the country via the telephone circuits and across the Atlantic by short waves.

In spite of the rapid development and use of every-day wire and radio facsimile service, many are unaware of its greater capabilities as a mass communications medium in the broadcasting field. This is largely because facsimile transmissions have been employed almost entirely to handle press photos for subsequent newspaper reproduction; in the average layman's mind this is the limitation of the method. Many also confuse television with facsimile and ask why television ultimately will not perform the same duty.

FACSIMILE, in its electrical communications sense, involves the conversion of illustrations or other copy, such as printed matter, photographs, line drawings, sketches, and so on, into electrical signals which can be sent over radio or telephone circuits. At the receiver, the signal is automatically converted back into visible form, appearing as a recorded replica of the original copy. The received copy is permanent and, like a printed page, can be handled, observed, or read whenever desired.

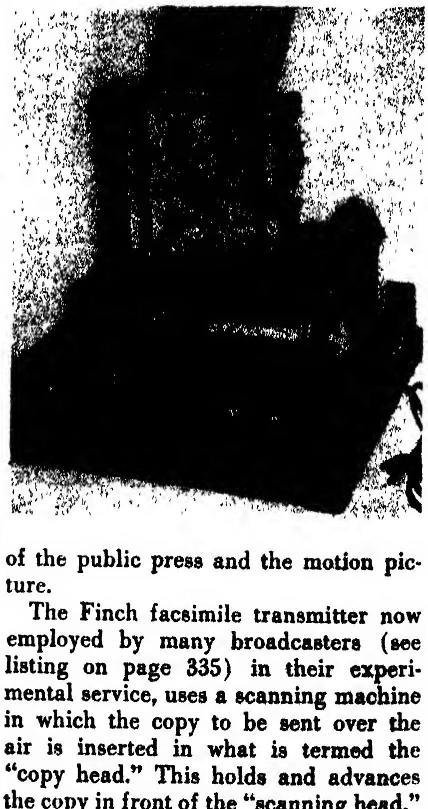
Television also involves the conversion of visible aspects of subjects into electrical signals which can be sent to distant points. However, the frequencies required for this conversion are such that ordinary telephone circuits or conventional sound broadcasting equipment cannot handle the signal. Costly coaxial cables with associated high frequency signalling apparatus or ultra-high frequency radio transmitters and receivers are therefore required.

Above: **The home "press room."** ***Right:*** **Interior of the facsimile recorder, showing the moving stylus.** ***Below:*** **Simplified diagram of the reproducer. The paper is moved upward by means of toothed wheels after each line is traced by the stylus**



In addition, there is as much difference in the technique of the two mediums of communication as there is between making a newspaper and a motion picture. Where facsimile is concerned with the transmission and subsequent recording of copies of still subjects such as pictures and printed pages, television deals with moving objects or persons. The image on the screen of a television receiver has the basic qualities of a motion picture. The image moves, it is transitional, and when the show is over the screen is blank. Since nothing has been recorded, the images will not be seen unless someone watches the screen when they are to be received.

Facsimile and television thus perform widely different functions. Each will fit into the communications picture as separate services, having fundamental distinctions as widely divergent as those of the public press and the motion picture.



The Finch facsimile transmitter now employed by many broadcasters (see listing on page 335) in their experimental service, uses a scanning machine in which the copy to be sent over the air is inserted in what is termed the "copy head." This holds and advances the copy in front of the "scanning head," consisting of a small electric bulb, lens system, and photo-cell. Light from the bulb is focused as a small spot on the surface of the paper carrying the copy; the reflected light is picked up by the photo-cell. The scanning head is moved from side to side by an electric motor so that the spot of light traces a series of parallel paths across the copy which is moved upward through a distance equal to the diameter of the light spot at the end of each scanning stroke. In this manner, the entire surface of the

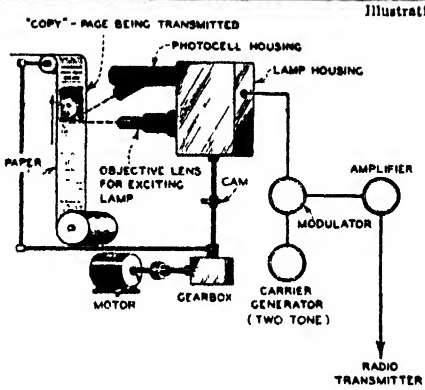
STATIONS LICENSED TO TRANSMIT "HOME NEWSPAPERS"

WLW	Cincinnati, Ohio
WOR	Newark, New Jersey
WGN	Chicago, Illinois
WSM	Nashville, Tennessee
WHO	Des Moines, Iowa
WSAI	Cincinnati, Ohio
WWJ	Detroit, Michigan
WHK	Cleveland, Ohio
KSTP	St. Paul, Minnesota
WCLE	Cleveland, Ohio
WGH	Newport News, Virginia
W8XAL	Cincinnati, Ohio
W8XNU	Cincinnati, Ohio

paper is scanned, line by line; the black, halftone, and white areas reflect to the photo-cell varying amounts of light ranging from minimum to maximum. These variations in reflected light effect a change in the amount of current flowing through the photo-cell. This current is fed to the radio transmitter in the same manner as sound broadcast signals are handled. Any conventional receiver tuned to the frequency of the transmitter will then pick up the signals which may be rendered audible by a loudspeaker, or used to operate a "home" facsimile recorder.

The recorders now in use are self-synchronizing. This is an important advantage; the recorder may be located in one state and the transmitter in another—the system does not depend upon local power lines for synchronization. Recorders are available for A.C. or D.C. operation, or for battery supply for farm use.

THE recording machine is similar in many ways to the scanning instrument. What is termed a "receiving copy head" holds the dry processed recording paper, which is fed as a continuous strip two newspaper columns wide from a roll carried in the lower part of the machine. A recording stylus is moved by a small electric motor from side to side across the surface of the paper, forming marks on the paper corresponding in position and shade to the elements of the copy at the transmitter. When the incoming signal is strongest the line traced by the passage of current is darkest; when it is weakest no mark is made. At the end of each of these recording strokes the paper is moved up by an amount equal to the width of each line element. By means of extremely short low-tone signal impulses sent out by the transmitter just before the start of each recording stroke, and by the use of a small motor turning over at a predetermined speed, the recording stylus moves across the paper in step with the scanning head of the transmitter, recording copy in its proper position. In this manner the recorded copy



Illustrations courtesy Finch Telecommunications Laboratories, Inc.

Above: **A photograph being scanned at the transmitter.** ***Left:*** **The diagram shows how light is reflected from "copy" to photo cell**

is built up line by line to appear as a duplicate of the original. One hundred lines will build an inch of reproduced copy; at the operating speed of the present machine, a two column newspaper will be "printed" at the rate of five feet per hour. It is not impractical to hope for a newspaper of five columns in the near future—tabloid size.

The actual home recording machine, which, it is claimed, can be made to sell for less than $50 in mass production, is small enough to be housed as a complete unit in a cabinet approximately a foot square. It may be connected without auxiliary amplifying equipment to the output circuit of any broadcast receiver having a power rating of three watts or more. In operation the broadcasting station from which facsimile signals are sent is tuned in with a receiver as would be the case if regular sound programs were to be received. The loudspeaker is switched off and the facsimile recorder is switched on; the volume control of the receiver is turned to the point where copy has the desired contrast. The resulting recording operation is wholly automatic and requires no attention. Paper costs will be about 15 cents per week.

Until the development of an automatic machine and inexpensive dry recording paper of wide latitude which requires no liquids for moistening or smudgy carbon transfers for printing, the adaptation of facsimile recording methods to home service seemed rather remote. Concentration on the automatic recording problem has resulted in the present-day home facsimile machine which safely operates without attention throughout long facsimile broadcasting periods.

During the present experimental period—and probably thereafter—facsimile broadcasts take place between midnight and 6 A.M. when sound broadcasting facilities are ordinarily idle. Time clocks will turn the radio receiver and recording motor on and off at specified hours. "Printing" of illustrated world events, bulletins with latest news flashes, photographs, market reports, weather maps, cartoons, recipes, and illustrated advertisements of all sorts, will thus be effected in homes while their occupants sleep, the machine being practically silent and entirely automatic in its operation.

THIS, to some who are not familiar with facsimile developments, may sound like one of H. G. Wells' prophecies. That it is not, is attested by the fact that at the present many of the leading major broadcasting stations in the country already have been granted FCC permits and have inaugurated such a service using regular broadcasting frequencies and full power in experimental transmissions to determine public reaction and to obtain basic engineering data for home facsimile services. In addition, other important stations have applied to the FCC and are considering the possibilities of facsimile service.

GIANT MOLECULES:

How Genetics, Youthful Science of Inheritance, Has produced Billions of Dollars of Wealth . . . Big Things that Boil Down to the Minutest Controls

THE remarkable discoveries in the youthful science of inheritance, genetics, have been applied to animal and plant breeding throughout civilization—and with almost incredible success. As regards the United States alone, during the past 30 years, even a conservative estimate of the cash value of the practical application of genetic findings would have to run into billions of dollars. Far greater yields of grains, fruits, vegetables, and cotton; far higher quality both in domestic plants and domestic animals of every description and their products, including milk, meat, eggs, and wool; increased and sometimes perfect resistance to disease; entirely new commercial varieties; and the lessening of the chances of famine: all these are in this story of science.

Thus, seemingly pure research into the machinery of inheritance has made possible stupendous progress in agriculture. This machinery works by controlling the development of the billions of cells, the tiny bits of living material or protoplasm which make up our bodies. Not only do certain cells develop into eye tissues or brain tissue under the influence of heredity's mechanism, but also each special group of cells submits to even more precise regulation: frequently so precise that you may inherit a startlingly exact copy of your father's nose, or mouth, or of your mother's brain, perhaps with its peculiar sort of "nervousness."

WE did not derive all our practically countless cells directly from our parents. Each parent provides only one cell. These two unite to form the first stage of our existence, the one-celled embryo. This tiny cell, multiplying by continued cell division, finally produces the fully mature body.

We are made up of billions of cells, and so, of course, as we recall, they are microscopic. Yet, small as they are, only a tiny fraction of each protoplasmic bit is involved in inheritance. If we could focus a fine microscope upon the single cell provided by one parent, and if this microscope were very powerful, we would discover, down near the limit of visibility, objects shaped like worms and called chromosomes. These chromosomes are made up of much smaller objects, the genes. At this point even the keenest microscope fails us—and scientists are not quite certain whether they can observe individual genes or, at best, clusters of genes. Nevertheless, all the evidence goes to prove that these minutest genes are the controllers of inheritance. And they have turned out to be giant molecules, each with some specific rôle to play in the development of color of hair, hardness of teeth, or some other of the thousands of characteristics which we inherit.

The science of genetics took its rise as late as the beginning of this century. That is, the first real approach to the understanding of the mechanism of heredity followed the discovery that practically the sole significant material which parents transmit to their offspring is the substance chromatin, the material of which all the wormlike chromosomes are made. It was found that chromatin makes up the chief portion of the sperm cell, the sex cell from the male. And in the case of the egg cell, the sex cell from the female, there appears to be little else but chromatin and reserve food. Hence, was it not logical to assume that chromatin contained the whole machinery for regulation of the offspring's development of its parents' characteristics?

The opening up of an entirely novel field of research placed the basic meaning of chromatin beyond any question. The highest honors for leadership in this field belong to Dr. T. H. Morgan, of the California Institution of Technology, who received the 1933 Nobel award in Medicine for his outstanding labors. The lowly vinegar fly, Drosophila melanogaster ("black-stomached fruit-lover"), has been in a major way the organism experimented with—though biologists have not neglected to check their results by ferreting out the secrets of wasps, barley, corn, wheat, primroses, jimpson weed, and many other living things. In this new branch of science, not only the chromosomes have been exhaustively investigated, but even the ultra-microscopic units out of which these wormlike rods are constructed. Modern scientific probing has penetrated down from the microscopically visible rods of chromatin to their constituent particles, the genes, whose measurements are in terms of a few hundred-thousandths of an inch.

More than 25,000,000 vinegar gnats have been examined. Excellent reasons lie behind this magnitudinous study. A human generation appears about every 25 years; the fruit-loving gnat reproduces in 12 days. Moreover, these gnats are readily raised by the tens of thousands in milk bottles in the laboratory. They have only four pairs of chromosomes, and it is not difficult to distinguish between the individual rods. Best of all, the vinegar fly has many heritable characteristics which are easily recognized: form of body, color, shape of wings; color of eyes; number and types of bristles; susceptibility to disease; and length of life. Finally, Morgan was awarded a Nobel prize in *Medicine*—because the laws of inheritance which apply to the fruit fly apply also to man. Like the fruit fly's body shape, human feeblemindedness, shortfingeredness, and color blindness show up, generation after generation, in response to the manner in which heredity's machinery operates throughout the animal and plant kingdoms.

MORGAN went far beyond merely proving that a given chromosome bears the determinants (genes) for a given characteristic, such as eye-color. By delicate and difficult technique, he demonstrated that a given determinant is located in a given region of a chromosome. Astoundingly, he was ultimately able to construct accurate maps of the chromosomal positions of the various physical bases of definite features of the species; that is, maps of gene locations. Tens of thousands of breedings have attested the accuracy of his chromosome mapping. Genes once had existence in theory alone. Today their existence is an established fact.

Now we are certain that behind susceptibility or resistance to disease in wheat or potato; production of milk with a high content of butter fat; liability to hog cholera; record egg-laying—behind these characteristics and many another valuable financially, lies the gene as the fundamental unit, out of which the machinery of inheritance is constructed.

Once bio-scientists became satisfied that the gene is a real, physical unit, they sought its structure, its properties, and its arrangement in the chromosomes. Their findings have been amazing, not merely to themselves, but to physicists and chemists as well.

Compounded of a million atoms yoked in a bafflingly intricate design, the gene is gigantic among molecules. Though of course as a molecule it is (probably) invisible even beneath the most powerful lenses, its dimensions are for a molecule actually tremendous: somewhere

THE MACHINERY OF INHERITANCE

By BARCLAY MOON NEWMAN

near a ten-thousandth of an inch in length, and some fraction of this measure in diameter.

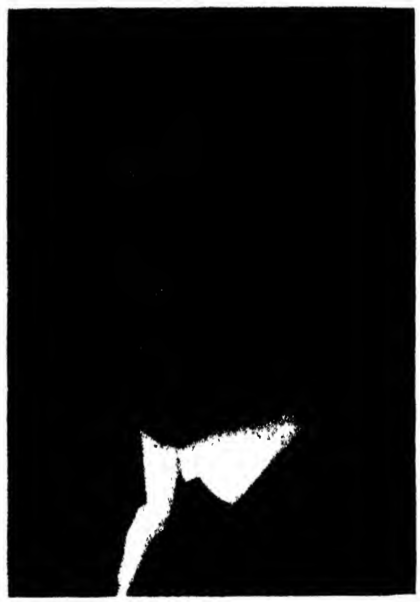
The chemical classification of this super-molecule seems to be with the proteins, which are exceedingly complex compounds of carbon, hydrogen, oxygen, nitrogen, often sulfur, phosphorus, and other elements, and which are assumed to be the truly essential molecules of life. Certainly, no live material without protein is known—or supposed to exist. Examples of proteins are hemoglobin, the pigment which gives red blood corpuscles their color; albumin, the main constituent of egg-white; and the milk protein, casein. The ultra-microscopic virus of mosaic disease of tobacco is another protein, recently obtained in bulk as glassy, needlelike crystals, each made up of countless molecules. These too are super-molecules—also with many an uncanny property of the gene.

The genes are strung end to end to form wisps, called chromonemas, and these fine threads are bound together to produce a chromosome. The machinery of inheritance therefore is no more and no less than a vast and stupendously intricate system of chemical systems -the basis of whose chemistry is the particle, the gene, a super-compound.

IN cell division, chromosomes are seen to reproduce themselves. The gene, the foundation of the chromosome's architecture, must do likewise. Or, rather, genes, by their individual multiplication, construct new chromosomes. Here is an almost unbelievable, a wholly novel, ability of a molecule: to create its like out of the lesser molecules of a suitable surrounding medium. Only in the gigantic virus protein have we discovered such a remarkable property—almost incredible to the physical scientist, who is used to far simpler aggregations of atoms.

For an approach to this problem of self-creation, or autosynthesis, we must consider the enzyme, also believed to be a formidable protein, though not so accomplished a one as the gene. Digestive ferments, such as trypsin of pancreatic juice, stimulate and regulate the breaking up of complex compounds into simpler molecules, known as amino acids, which the body can then assimilate. This disintegration can be reversed, however: an enzyme under appropriate conditions works backward—builds up amino acids into proteins (or unites them into protein-like compounds). If a super-enzyme had the power to fashion not simply great molecules out of small ones, but moreover great molecules precisely like itself, would we not have autosynthesis, as in the gene? And so it is thought that a clearer idea of the workings of enzymes may give us a better grasp of the self-production of giant molecules, like the genes, the cogs in heredity's mechanism.

In the first 25,000,000 fruit gnats studied, about 500 heritable changes in eye-color, length of life, susceptibility to



Dr. T. H. Morgan, economically the nation's most significant Morgan

germs, showed up. Such heritable modifications of the ancestral characteristics are mutations. For example, every so often a young gnat, offspring of red-eyed ancestors, is born with the mutation, white eyes. Man has made valuable use of natural mutants like the seedless orange and rust-resistant wheat.

How do the genes, linked by the thousands to make chromonemas, cooperate to change a microscopic, one-celled embryo into a billion-celled man —and even a man very closely resembling his parents? We must assume that the genes have the ability not only to reproduce themselves, but, still more like super-enzymes, to start, regulate, modify, and terminate the biochemical reactions which, all together, mean life—and growth of many diverse tissues and organs and organ systems into a body astonishingly similar to that of the preceding generation. Incomparable abilities!

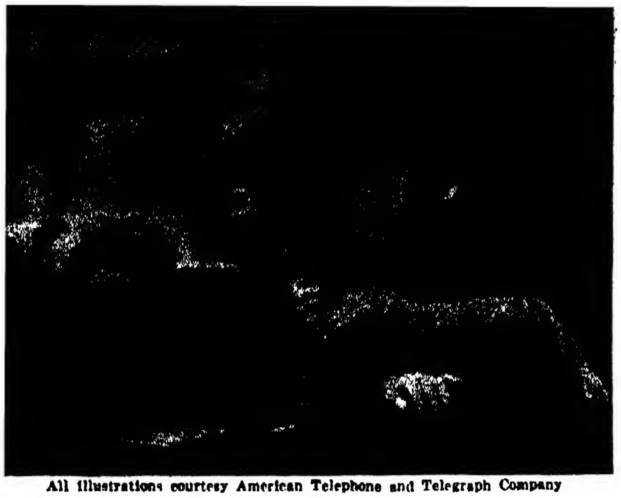
We have to speculate that the gene, as a super-enzyme, causes a bafflingly complex chain of chemical processes in the protoplasm in which the chromosomes swim. And this chain must include the production of innumerable stimulators and regulators; that is, enzymes, every one with its kingdom of biochemistry to supervise and keep harmonious.

Far from halting his labors in despair at the vastness of such chemical systems, the embryologist has persisted in his attack upon these deepest mysteries of vital existence. Thus, recently, he has been able to exhibit the presence, in the developing animal, of substances called organizers, which promise to turn out to be super-enzymes, given substance and activity through the agency of the genes.

IN 1900, Dr. Hans Spemann, now of the University of Freiburg, Germany, began a laborious series of researches upon the embryology of amphibians, including newts and salamanders. He cut newt eggs and young embryos into pieces, and observed the development of these pieces with a view toward finding the stages at which special determiners of particular kinds of tissues appear—or might appear. He transplanted bits from an early embryo to certain definite sections of more fully developed embryos, to watch the effects of possible early-appearing or late-appearing super-enzymes, or organizers. In the course of these experiments, from one embryo he took tissue which would normally produce the spinal cord of the young animal, and transplanted this tissue into another embryo. A spinal cord came into being in the second animal where one would not ordinarily be formed. Hence, the transplanted cells must manufacture organizers which stimulate surrounding cells to change into a particular kind of structure: a spinal cord, in this case.

Spemann's work established the fact that an organizer determines whether a group of cells becomes spinal cord or becomes skin, or some other sort of tissue; and that such activators bring about the growth of organs each in its own proper place and each with its own proper functions. His achievement won him a Nobel award in 1935.

The transformation of the single-celled offspring into smoothly functioning adult, with billions of cells, must involve many a super-molecule, the delight of the biologist and the confusion of the physical scientist.



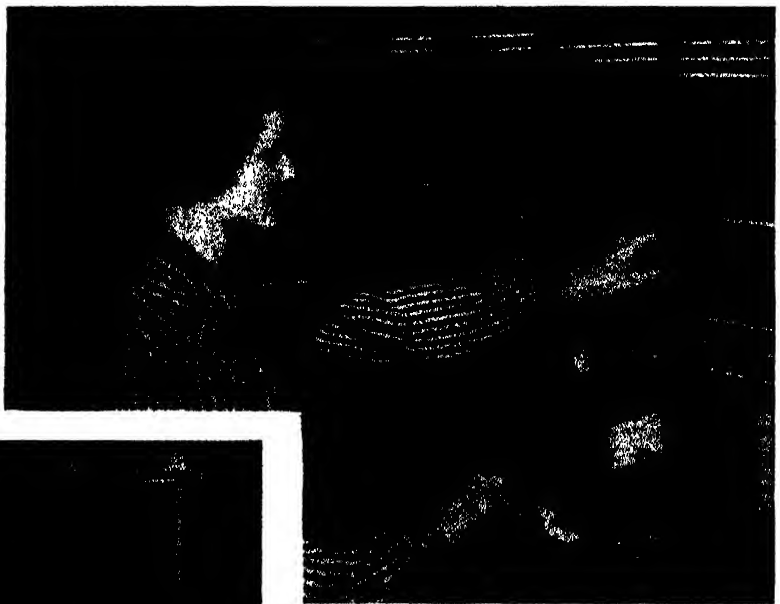
All illustrations courtesy American Telephone and Telegraph Company

'AMERICA CALLING'

How A Transatlantic 'Phone Call is Made

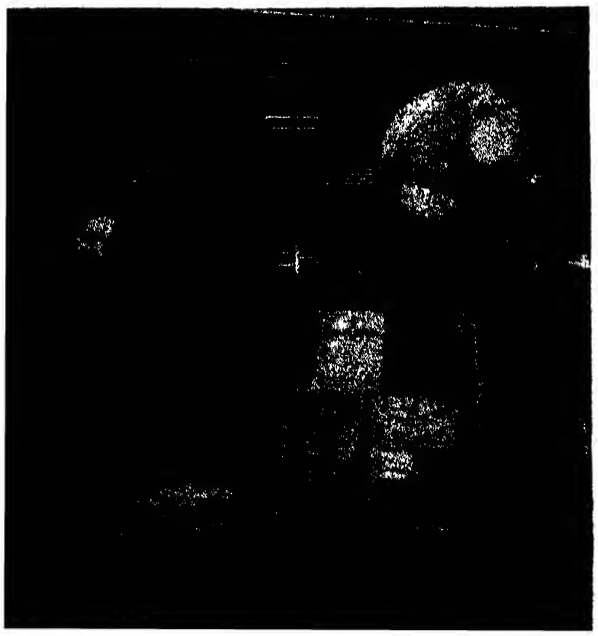
By A. P. PECK

1 Within an average of 12 minutes after an American subscriber puts in a call for a party in London, the connection is made and conversation is carried on as clearly and easily as if the called party were only a few blocks away. Behind this commonplace occurrence (an average of 50,000 overseas calls are made yearly, 60 to 65 percent of them being transatlantic), there is a vast array of technical developments and their application, aimed toward maintenance of service and speech quality



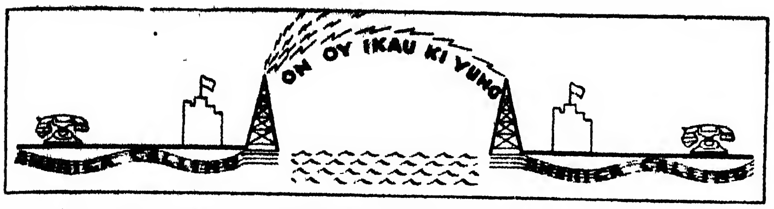
2 The United States subscriber making the call asks his local operator for "Long Distance" (*above*); she in turn connects him with one of the operators at the switchboard through which all overseas calls are handled, shown at 3

3 *Left:* The "Overseas" board through which passes the call to London. Here are handled most of the 'phone calls set up between the United States and foreign countries by wire and radio telephony. First duty of an operator receiving a call at this board is to write down all details of the destination of that particular call

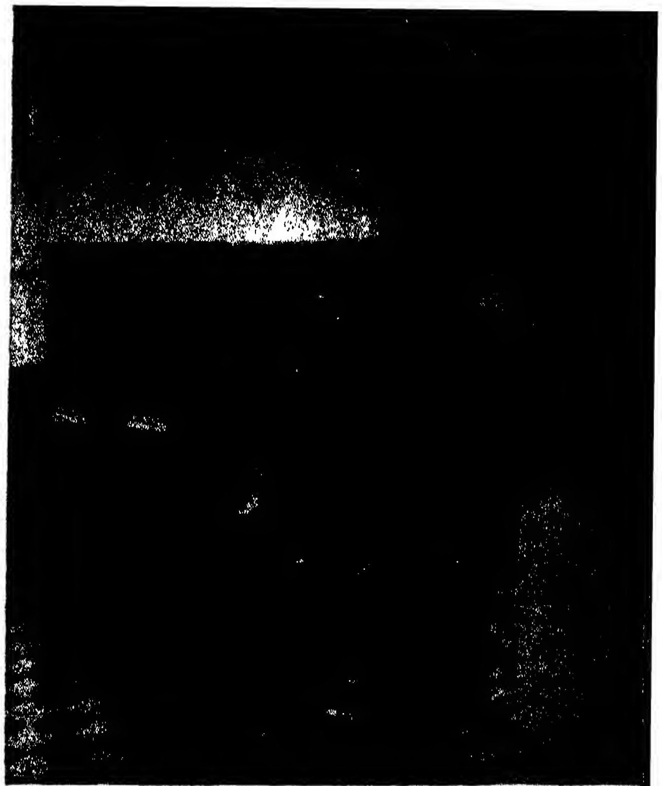


4 *Left:* After the "Overseas" operator looks up the number of the called party in London, she passes the information to the London operator over the radio circuit. At the desk shown are assembled 'phone books of the principal foreign cities reached by the radio service

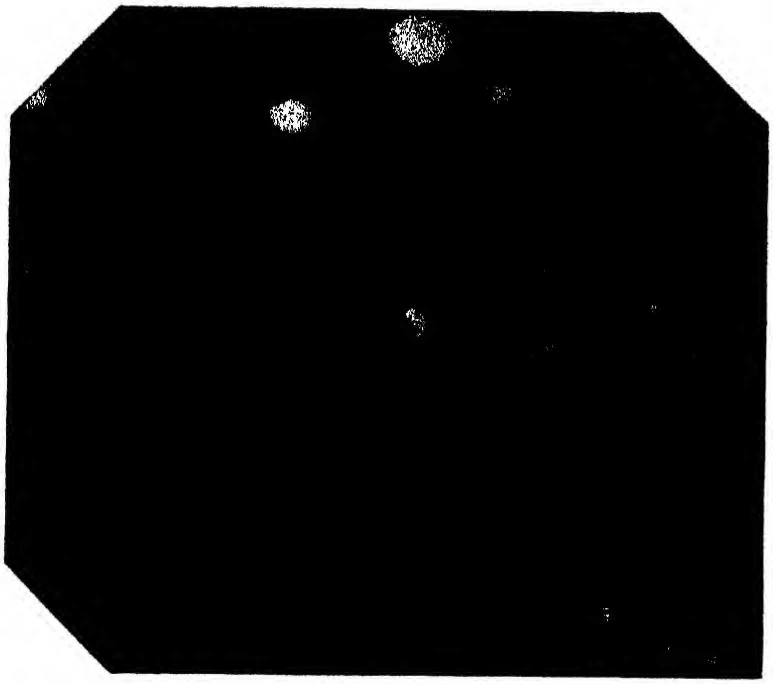
5 *Right:* The wire part of the overseas circuit passes through the control room in the same building as the switchboard. Here operators maintain a constant watch on the apparatus; here also outgoing speech is "scrambled"



6 To insure privacy of overseas telephony, speech is "scrambled," or inverted in frequency; anyone listening in with a radio receiver would hear sounds resembling almost anything but coherent speech. The above drawing, fanciful in its execution, shows briefly what happens. The voice frequencies of "America calling" are scrambled to sound something like "on oy ikau ki yung"; they are unscrambled when they reach the receiver



7 From the control room shown at 5, a wire line carries the voice of the speaker to a short-wave transmitting station at Lawrenceville, New Jersey (*above*), whence it is hurled across the Atlantic by a directive radio antenna system, picked up at a receiving station near London, and sent on its way once more by wire



8 *Left:* The radio control room in the London Trunk Exchange, where the voice from the United States is unscrambled. Here also operators keep check on the functioning of all associated apparatus, and control the volume of current passing through the circuit so that transmitted speech will at all times be within the easily audible range—neither too loud nor too low for perfect understanding

9 From the radio control room the incoming voice is passed by wire to the International Exchange in the same building, whence it is routed through the local telephone exchange system and finally reaches the party being called

10 *Right:* The call is completed. Quickly and without hitch, two parties on opposite sides of the Atlantic have been connected by wire and radio, an accomplishment made possible by the findings of intensive scientific research

PERSONALITIES OF

Why the Diamond is so Hard and Copper Soft...Why Silicon Carbide Abrasives are Exceedingly Hard ...Other "Whys" in Terms of Their Fundamentals

METALS, like people, have personalities. Some metals, such as gold, silver and copper, are soft and yielding; they can be stretched into fine wires or flattened into sheets a thousandth of an inch thick; still the parts cling together. They are the best conductors of electricity we know. Other metals, such as tungsten, vanadium, chromium, and bismuth, are hard and unyielding. When struck with a hammer they shatter into splinters or crumble to powders. A fine tungsten filament is just the thing for an electric lamp, for tungsten is a rather poor conductor of electricity. So great is the resistance offered to the passage of the electric current that the filament becomes white-hot. Fortunately for the electric lighting industry, tungsten has the highest melting point of all the metals.

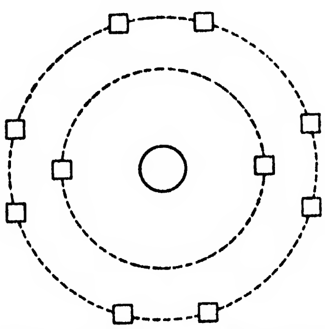


Figure 1: **In the neon atom the nucleus is guarded by eight outpost electrons: a self-contained unit**

Pure metals are chemical elements—as are pure non-metals such as the diamond, sulfur, and the glowing neon gas so widely used in advertising signs.

Has science any way of explaining the personalities of the many elements or shall we merely accept them as God-given attributes? Can science tell us why the diamond, which is nothing but pure carbon, is the hardest substance known and a total non-conductor of electricity; why neon is a gas; why sulfur is brittle and crumbly and an excellent insulator; why copper is soft and yielding and the best cheap conductor of electricity, while titanium is hard, brittle, and a poor conductor of electricity?

As human behavior seems to be controlled largely by the genes, those tiny biological regulators of heredity, so too the behaviors of the elements seem to be controlled by the electrons, genes of the atom. Science has long realized that elements are made up of atoms and that the atoms of any given element are alike—far more alike than peas in a pod. When we look at a piece of gold, we are looking at untold billions of gold atoms lined up in some kind of orderly array, each atom held in some mysterious manner to its neighbor atoms. In the diamond, too, is orderliness, even more regularity than in gold, with each of the myriad carbon atoms joined to its fellows in a definite pattern. What determines this orderliness? It is the number and arrangement of the electrons.

In the past decade or two, science has probed deeply into the atom with its delicate electrical probes to discover that the atom, itself, is not the tiny, hard ball we once imagined but a complex affair indeed. Each atom might well be likened to a company of soldiers in war maneuvers. There are large and small companies comparable with light and heavy atoms. In the center, compactly massed, is the main body of troops representing the nucleus of the atom—and its mass. Far out on the flanks, guarding the main body and acting as contact patrols, are the flanking electrons, small in mass but highly important. Small companies will have out but few of these flanking patrols, while larger forces will be surrounded and guarded by many flanking units. Thus we may picture the atom as a central mass, the nucleus, small in size but heavy in weight, surrounded at some distance by flanking electrons, the number of such electrons depending on the massiveness of the nucleus.

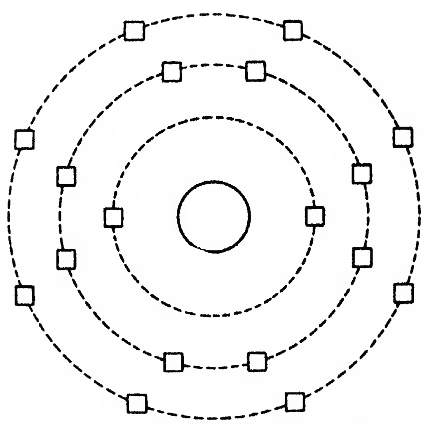


Figure 2: **The argon atom, though larger and heavier than the neon atom, also has eight outpost electrons and is a self-contained unit**

IT is to these flanking electrons that we turn in order to understand the behavior of the atom and the element. As in any well organized fighting force, the electrons are assigned positions in flanking zones. If a zone is full—and a complete outer flanking zone never contains more than eight electrons—additional electrons must take up positions beyond the completed zone. The atoms of some elements have their outpost zone complete with eight electrons. This magic number constitutes a perfect defense. The atom is guarded on all sides and the eight flanking electrons form, as it were, a magic and impenetrable ring. Such atoms are self-contained units. They need not—in fact never do—herd together in flocks or fleets for mutual defense. Each atom travels its solitary path independent of its fellows. If there is no herding together there can be no solid, and elements whose atoms have such perfect symmetry will be gases. Such elements are the so-called noble gases: helium, neon, and argon (Figures 1, 2). The flanking electrons hold tight to the atom and, while they can be loosened and temporarily removed, they flip back into place again in a hurry. The scientist explains the colorful glow of neon gas as due to this flipping back of electrons when they are temporarily displaced by a high-voltage discharge.

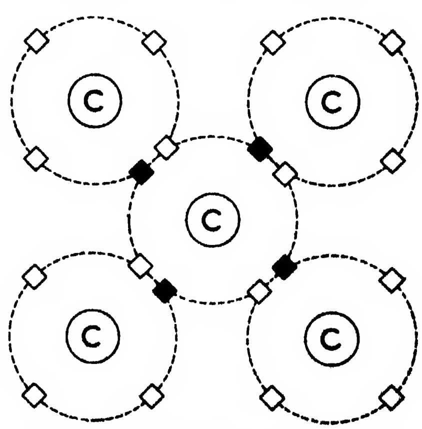


Figure 3: **By co-operative sharing, the central carbon atom obtains an outpost zone of eight electrons**

THE ELEMENTS

By SIDNEY J. FRENCH, Ph.D.

Assistant Professor of Chemistry at Colgate University

In the noble gases there is a complete isolation of atoms and a complete lack of co-operation between atoms; but next, in contrast, let us turn to the diamond as an example of the most complete and perfect co-operation between atoms. The diamond is composed entirely of carbon atoms and carbon atoms are highly gregarious. We return once more to our war-like analogy. Each carbon

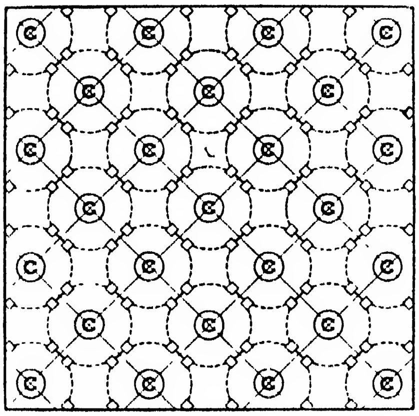


Figure 4: **Arrangement of carbon atoms in the diamond, showing why the diamond is so hard: its atoms are compact and tightly locked**

atom has four flanking outpost electrons—just half of the magic number of eight. Imagine, if you will, five carbon companies in war maneuvers, a central company surrounded by four others. Each company must maintain contact with the others through its four flanking contact patrols. Patrols from adjacent companies pair off, giving the central company eight patrols around it—again the magic number (Figure 3). But this is a process of sharing patrols; there is no self-contained unit. These co-operating patrols serve to hold the companies in a fixed and rigid relationship to one another. There can be no skewing of the battle front or lagging behind of one flank. This, then, constitutes the acme of perfect co-operation, perfect sharing of responsibilities. In the diamond each carbon atom is attached to its four surrounding neighbors by pairs of flanking electrons, one member of the pair coming from each atom. Only on the outside of the diamond is the symmetry of eight electrons incomplete. Since this co-operative sharing process can be continued indefinitely there is no theoretical limit to the size of a diamond crystal. It is no wonder that the diamond is the hardest substance known to man, for the atoms are small and the co-operating electrons hold the many atoms in a tight and rigid embrace (Figure 4).

But, there is still one puzzling fact to be explained. Everyone knows that electrons are negatively charged and everyone likewise knows that negative charges repel one another. How, then, is it possible for two electrons to co-operate as a pair in holding atoms together? Science believes that these electrons spin like tiny tops. Each is a little dynamo setting up a magnetic field around it. If two electrons are spinning in the same direction, these fields will repel one another. If, however, the electrons spin in opposite directions, the fields may interlock, drawing the electrons together as a co-operating pair. Like two gear wheels in mesh, they work together while spinning in opposite directions.

Though silicon atoms are somewhat

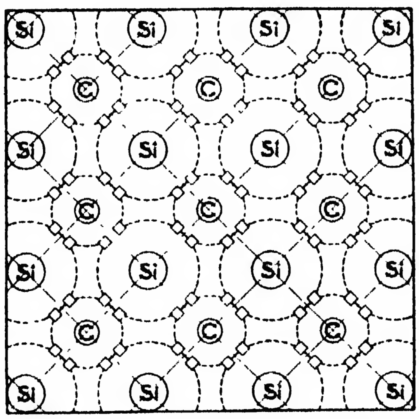


Figure 5: **Arrangement of carbon and silicon atoms in Carborundum. Each silicon atom is surrounded by four carbon atoms and each atom of carbon by four silicons; yet by the sharing method each interior atom has eight electrons**

heavier and larger than carbon atoms and possess eight more flanking electrons, the arrangement of the electrons is such that there are again four outpost electrons. So silicon, like carbon, forms hard, rigid crystals; but, more than that, silicon and carbon atoms can be alternated in a common crystal just as companies of French and Moroccan troops might co-operate through their contact patrols. This compound, silicon carbide, known commercially as Carborundum, is almost as hard as the diamond and is commonly used as an abrasive.

We may safely conclude that this perfect co-operation between atoms possessing four outpost electrons to provide eight electrons around each interior atom results in extremely hard, brittle substances.

WHEN we turn to the metals we find a quite different situation (Figure 6). The copper atom has but one outpost electron. Obviously, copper atoms cannot be self-contained units like neon atoms, nor yet units capable of perfect co-operation like carbon atoms. The lone electron has an immense space to guard. It must be an electron with a good mount capable of great mobility if it is to maintain contact between numerous neighboring atoms. It must be first on one side of the atom, then on the other, pulsating, as it were, between atoms. With such conditions existing there can be no great rigidity of formation. There can be skewing and lagging; atoms can slide past one another to take up new positions but still the lone contact electrons keep the atoms from falling apart. The copper atom army is one of great flexibility. No wonder copper can be pounded into thin sheets; these atoms slide easily into their new positions (Figure 7). Then too they may be strung out one after the other in fine wires.

Now copper is an excellent conductor of both heat and electricity, while the diamond conducts neither. Heat causes atoms to vibrate more rapidly; mobile atoms can transmit such vibrations from one to the other easily while atoms held rigidly in place cannot. Thus is explained in simplest terms the ability of

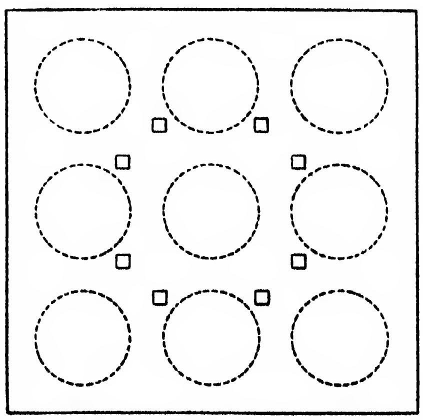


Figure 6: **In metal atomic structures there are too few electrons to be shared in fixed positions between atoms, consequently the electrons are mobile, free to move**

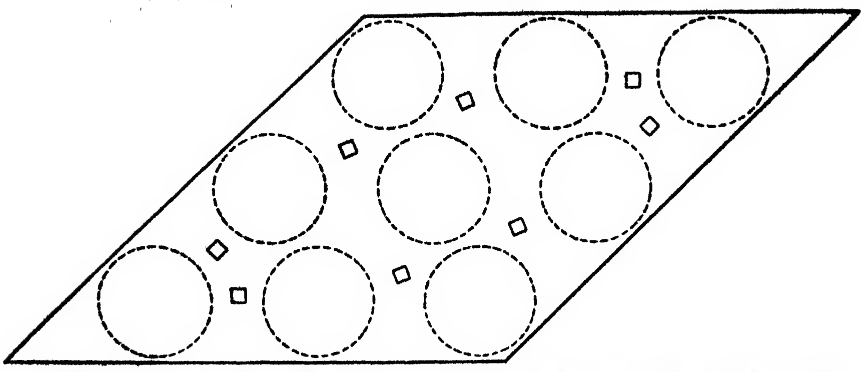


Figure 7: **Metals can be flattened out and worked because the lone outpost electrons are not capable of holding the component atoms in rigid positions**

copper and the inability of a diamond to conduct heat.

Modern science regards an electric current as a flow of electrons. As the jerk of a locomotive transmits the jerky impulse successively to car after car of the following train, so electrons are thought to transmit the electrical impulse to successive electrons. When electrons from a battery are shoved in at one end of a wire, there is a continuous displacement along the line to the other end where the electrons may be removed (Figure 8). We have, in effect, a line of dominoes standing on end. As the first is knocked over, it transmits the impulse to the next and successively to each in turn.

Without mobile electrons there can be no transmission of the electrical impulse. The greater the mobility, the greater the ease of passage of the electrical current. Hence, copper, silver, and gold, with but one outpost electron per atom, are our best electrical conductors. In the diamond electrons are in fixed and rigid positions and in symmetrical groupings. There is no mobility; hence the diamond is a non-conductor of electricity.

WE have described in some detail three fundamental types of atoms, those which possess eight flanking electrons and are self-contained, those which possess four flanking electrons and represent the acme of co-operation, and those which possess but one flanking electron to form the mobile metals. We have passed from the most perfect gases through the most perfect and most rigid of substances to the very soft and yielding metals. We have pointed out three extremes of personality: the self-contained, the co-operative, and the mobile. Intermediately we should find intermediate personalities and so we do.

Metals whose atoms possess two flanking electrons are as a rule somewhat harder than copper and are fairly good conductors of heat and electricity, while metals with three flanking electrons are still harder and are poor conductors of electricity. Some elements possessing five, six, or seven flanking electrons are gases because of the ability of two atoms to co-operate in sharing electrons and thus build up symmetrical flanking units of eight. Here, however, each independent unit is not an atom but a pair of atoms co-operating as a stable combination. Others of these elements, like sulfur, are solids, somewhat brittle and crumbly and non-conductors of electricity. In them the sharing of co-operating electrons is, at best, an imperfect one and none of these solid elements approaches the diamond in hardness and few have the luster so characteristic of metals.

However, the entire story has not yet been told. The element titanium, though hard and brittle, is a fair conductor of electricity and is definitely a metal. But, like carbon, its atom has four flanking electrons. This should make it, like carbon, a non-metal. Evidently the mere number of flanking electrons does not tell the entire story. Let us return once more to our analogy. Titanium is a much larger and heavier atom than carbon and possesses four zones of flanking electrons where carbon has but two. Obviously, the outpost electrons will be far from the nucleus and the titanium companies far apart. The contact patrols have a large area to cover and protect; hence, they must be considerably more mobile than those of the carbon atoms. We find that this greater mobility has a considerable effect on the behavior of the element. It is more metal-like in its personality. Thus, as an increase in the number of electrons tends to make the element less metallic, so an increase in the weight and size of the atom may in part offset this tendency.

There is still another factor which tends to make these heavy atoms more metallic in nature. In atoms having three or more outpost electrons one pair of electrons often tends to drop back into a zone nearer the nucleus. For example, aluminum atoms possess three outpost electrons, yet aluminum is a rather soft and yielding metal and conducts electricity well. As a metal it might well be classed with copper, silver, and gold as having but one outpost electron. Bismuth, in spite of its five outpost electrons, is definitely metallic, though it is hard and brittle. Its metallic nature can be attributed both to the massiveness of its atoms and the tendency of one pair of electrons to drop back from the outpost zone.

THE personalities of the elements are not reflected in their electrons but determined by their electrons—"genes" of the atom. At all times their behaviors are predictable and consistent, for genes are constant. Standing at one end of the line of elements are the noble gases, exemplified by neon, with their symmetrical structures of eight electrons and their self contained, rugged atoms. In the center of the line is carbon, greatest exponent of communistic sharing; each atom is joined to four fellows through the medium of its four electrons with rigid and unyielding bonds. At the other end of the line stand copper, silver, and gold, soft and yielding, adaptable and flexible, poor in electron genes but rich in mobility.

Dominating the entire line is the "rule of eight." It was by arranging the elements in order of the increasing weights of their atoms that Dmitri Mendeléeff, back in 1868—long before electrons were known—discovered this famous "law of octaves," the periodic law of the elements. With the discovery of the electron came a striking verification of this great law—and its explanation: when a quota of *eight* electrons is complete a new zone begins. In rows of eight, then, each row a graded period, one row beneath another; and in seried columns, each column a chemical family, shrewd Dmitri Ivanovitch Mendeléeff characterized the elements each in its own personality frame, yet each related to all others in his remarkable periodic table.

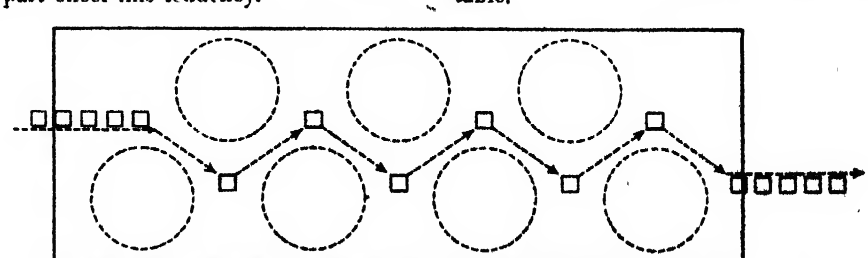


Figure 8: **Diagrammatic representation of the conduction of electricity by a metal. (All the figures in this article are diagrammatic.) Electrons enter the wire at the left, are displaced from atom to atom, and leave at the right. In an actual cross-section of wire there would, of course, be billions of atoms**

SHARK SHOOTING FOR SPORT

UNTIL recently used solely by commercial fishermen for harpooning swordfish, a Swedish harpoon gun has now become a part of the equipment of sport fishermen. A 10-gage shotgun shell gives it an accurate range of 75 feet, after which the attached harpoon line offers sufficient drag to pull the iron down.

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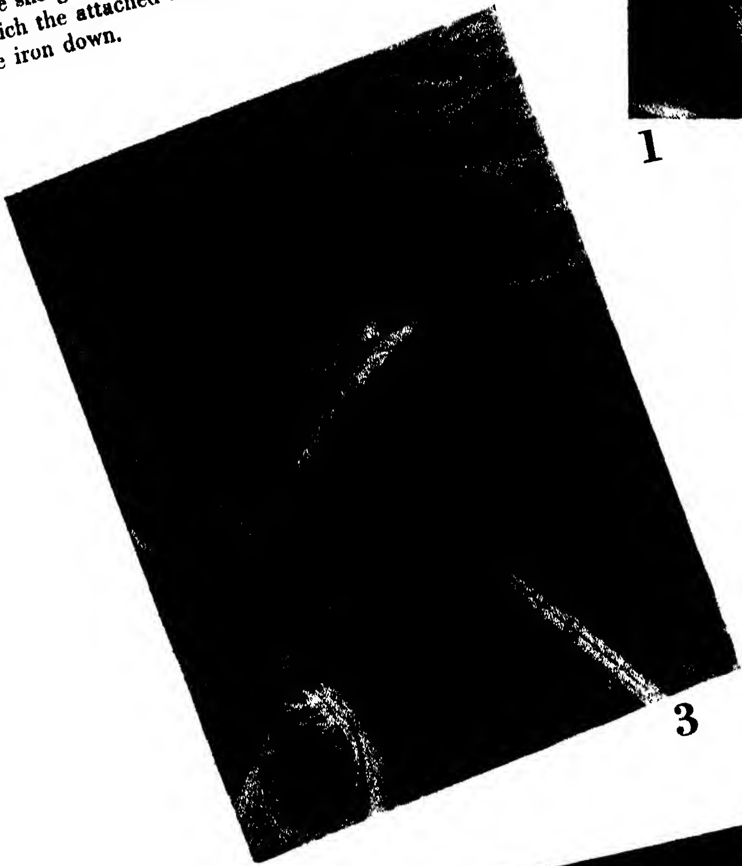

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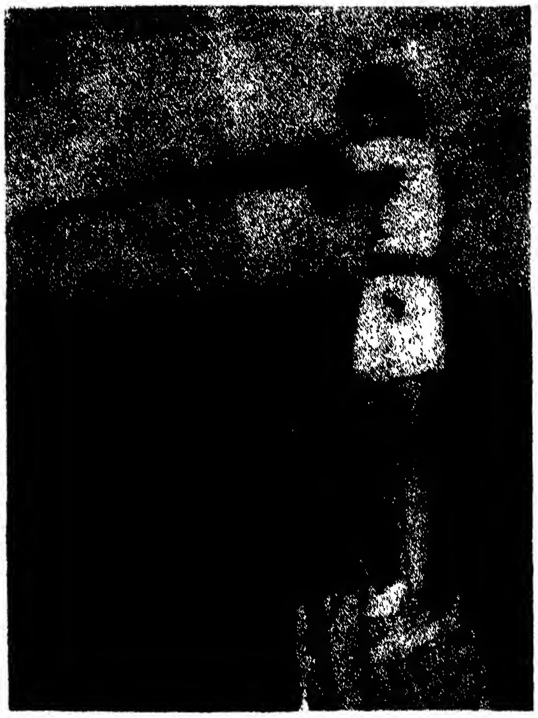

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Thrills of deep-sea fishing are combined with those of big-game hunting when the quarry is a huge shark and the weapon is a harpoon gun. The photographs show the use of the gun and include an unusual picture of a shark that has been successfully harpooned. At 1, Jean Smythe, wearing her catalin sailfish emblem awarded for entering the first sailfish in a recent West Palm Beach Fishing Derby, is loading the steel dart, with line attached, into the gun barrel. A shark sighted and the boat maneuvered to position, she takes aim, 2, at the huge hammer-head swimming under the pulpit, 3. A squeeze of the trigger and the steel dart sinks home. Thrashing in the water, twisting and turning in its endeavors to shake off the dart or slash the line, the shark is shown in the water at 4. After harpooning, the 12-foot fish is played to the boat and dispatched

STERILIZING WITH 'LIGHT'

Microbe "Death Ray" . . . Invisible Ultra-Violet Rays Kill Bacteria . . . Harmless to Humans . . . Inexpensive . . . Lamp for Hospitals, Food Handlers

By F. D. McHUGH

NEW patrons of a bank at Suffern, New York, are puzzled these days by a curtain of pale bluish light that falls between them and the tellers, along the grilled windows. For some reason, bank patrons try to get as close to tellers as possible, and bank employees suffer more than an average number of colds. Invisible radiation emitted by slender 30-inch tubes at the tops of the grilles protect tellers in this bank from infection.

Casual buyers of meats in the Economy Stores, of Boston, have recently become acquainted with the same "lights," and with a new word, "rentschlerization." In a cafeteria at Bloomfield, New Jersey, drinking glasses as well as meats and other perishable foods are "rentschlerized." In the operating rooms of Duke Hospital, Perth Amboy Hospital, and others, the faint bluish light streams down on operating areas, with the result that operating-room infections, ordinarily met with in several out of each hundred major operations, now are almost unknown in these hospitals.

ALL these are indications that effective, economical sterilization with ultra-violet radiation is here. Bacteriologists have known, almost since the days of Pasteur, that ultra-violet radiations would kill microbes. But attempts to put this knowledge to practical use on a wide scale have failed, because ultra-violet lamps used in the efforts have produced, along with the germ-killing radiation, unpleasant quantities of ozone and heat; have been expensive to make and operate; and have required high intensities of output to produce the necessary degree of sterilization.

The ultra-violet spectrum, though invisible to the eye, contains many more "colors" or different wavelengths than even the visible spectrum. Ordinary ultra-violet lamps emit most of these "colors," though it is well known that some have little or no effect on bacteria, while others produce such special effects as tanning the skin, forming ozone in the air, and the like. Appreciable power is necessary to produce this enormous long spectrum of invisible light; ordinary ultra-violet lamps operate hot, are expensive to make, may be dangerous, and the bactericidal effect is low in efficiency.

The heat emitted by such lamps makes their use uneconomical, for example, in refrigerators. When used to aid in the sterilization of meats and other foods, it was found that the ozone produced by some of the wavelengths hastened rancidity in fats. The lamps required the use of quartz envelopes to transmit the ultra-violet radiation, and thus were so expensive that they were not commercially practical for sterilization. Furthermore, they required too much electric power to operate.

A solution to this problem of making light-sterilization practical cost Dr. Harvey C. Rentschler, Director of Research of the Westinghouse Lamp Division, and his associate, Dr. Robert F. James, staff bacteriologist, more than five years of research. Because what they developed is both a radiation source and a method of using the radiations, it has been formally and formidably named "the Rentschler-James Process of sterilization with ultra-violet radiation." In meat and food shops, at soda fountains and taverns where the process is used, it has already been shortened to "rentschlerization."

The process is both simple and inexpensive.

It was known that some portions of the ultra-violet spectrum killed bacteria more effectively than others, but these regions were not exactly defined. Dr. Rentschler's first task was to invent a meter that would measure accurately the amount of invisible radiation of any selected wavelength (or "color") being emitted by his experimental lamps. His ultra-violet meter, the outcome of this preliminary research, is now used throughout industry wherever ultra-violet is used in any process.

The next step was to test, tediously and painstakingly, the effect of various ultra-violet wavebands upon bacteria and other micro-organisms. This task, alone, could have consumed a lifetime of effort, had not Dr. Rentschler and Dr. James devised a rapid method of making bacteriological tests. They confirmed the belief of other physicists and bacteriologists that some portions of the ultra-violet were more deadly to microbes than others. Moreover, they found the wave-band which appeared to be the most effective. This microbe death-ray—harmless to humans—has no name, but is designated as in the neighborhood of the 2537 Angstrom unit band.

With this knowledge, they undertook to devise a lamp that would be sturdy, inexpensive to make and operate, and of such shape as to provide the greatest germ-killing power over the area to be sterilized. When they had decided upon some sort of gas-discharge lamp containing a bit of mercury vapor and several other light-emitting gases, there still remained a special problem: Ordinary glass is opaque to a wavelength of 2537 Angstroms. Drs. Rentschler and James found their answer to this problem in a special glass that is particularly free of iron, a metal that strongly absorbs the bacteria-killing wavelengths. The first "Sterilamps" were thus created in the Westinghouse laboratory at Bloomfield, New Jersey.

When news of the Sterilamp reached the medical profession, Dr. Deryl Hart,

A large refrigerator equipped with the new "lights" to protect and preserve meats

Surgeon-in-Chief of Duke Hospital, Durham, North Carolina, immediately asked for a chance to experiment with it. Preliminary tests were so satisfactory that operations were then performed on patients, beneath the Sterilamp, and from the first the results were striking. While the bactericidal radiation did not eliminate more than 80 to 90 percent of the bacteria in the extreme corners of the room, it did kill virtually all the bacteria in the air about the operative wound and the supply and instrument tables.

In a cafeteria, a customer takes a water glass from a rack over which two Sterilamp tubes are mounted to sterilize the glasses and prevent growth of bacterial colonies by air-borne germs

Two laboratory petri plates exposed to air in a cow stable. Bacterial growth on one at left is from contaminated air, while one at right is kept free of air bacteria by rays from the new lights

Those major operations performed with the radiation showed no infection and the post-operative temperature curves of the patients were much lower than previously. As a result of Dr. Hart's successful experiments, Sterilamps have since been installed at the Mayo Clinic, Rochester, Minnesota; the New York Medical Center; the Perth Amboy, New Jersey, Hospital; and elsewhere.

Another problem to which the Sterilamps are readily applied is that of cheaply and effectively sterilizing drinking glasses and other utensils in restaurants, bars, and soda fountains.

In a recent survey published in *Survey Graphic*, Roger William Riis disclosed results of a test conducted on glasses in several New York City soda fountains picked at random. Water-glass rims produced 37, 112, 225, and 330 bacterial colonies; milk glasses produced 114 colonies; fruit juice glasses 115 and 444. In another test, 12 office workers were asked to kiss sterile plates. Each kiss produced from 10 to 560 bacterial colonies.

Two professors of Michigan State College, investigating public drinking places in Lansing, found as many as 100,000 bacteria on a single glass. Bacteriologists at Massachusetts State College beat them by 250,000 germs per glass. An examination of glasses at soda fountains in Montgomery, Alabama, revealed that 40 percent of those found were pathogenic—disease-producing.

So well known has this condition been that years ago the majority of states and hundreds of communities passed what were meant to be stringent ordinances requiring the sterilization of eating and drinking utensils. Forty-six states today have such laws on the books, but in general they are not enforced, because it is recognized that none of the sterilizing methods—chemical, hot-water, or steam—is practical. To meet this problem, Sterilamps are installed in series along the inside baffles of bars and soda fountains, in wire glass-holders, or any other convenient form. They operate at temperatures only four or five degrees above room temperature. They give 99.99 percent sterilization in a few seconds' time and maintain constant sterility up to the time of using.

LAST year an epidemic of septic sore throat was traced to its source in a railroad terminal in the New York area. Within two days it had reached several commuters' towns along the railroad line. Meanwhile, what had been one case of septic sore throat in a commuting New York business man was transmitted to his wife, thence to the maid, the children, and finally throughout the community. Moving picture theaters and lunchrooms were examined. In one of the latter, traces of septic sore throat organisms were found in the water used to wash glasses and eating utensils. The proprietor was co-operative. Sterilamps were then installed, and septic sore throat was stamped out at that focal point and kept from re-appearing.

Since bacteria and mold usually found on meats in storage are killed by the Sterilamp, low-temperature storage in meat shops becomes unnecessary. The refrigerator needs only to chill the meat enough to prevent flabbiness and render it firm enough to be cut readily and neatly. Use of Sterilamps does not, therefore, make refrigeration unnecessary, but it appreciably reduces the cost of refrigeration. Results from experimental installations indicate other advantages, too, including reduction of dehydration loss from 6 percent down to 1 percent of total meat purchases; reduction of trimming loss from 10 percent to less than 5 percent; and so on.

An installation of Sterilamps in a refrigerator of Scherer & Company, Mahwah, New Jersey, has resulted in an increase in meat sales of more than 50 percent in eight months, without any advertising or publicity. The store owners report that many of the regular customers are now requesting outside cuts. They also estimate an annual saving of 830 dollars due to reduction in mold, slime, and dehydration losses. The operating cost of the installation, including Sterilamp renewals at six-month intervals, is 130 dollars a year.

IN the baking industry, the Sterilamp has been put to practical use by several companies. Two large firms have been using the lamp to retard mold growth on fruit cakes. Before the lamps were installed, spoilage on the cakes amounted to about 15 percent. After exposure to the radiation and after certain changes had been made in the baking set-up, spoilage fell to a trifling 1 or 2 percent. Most of this improvement has been credited to the lamps.

Drs. Rentschler and James still consider the Sterilamp so new, and its possibilities so enormous, that they are unwilling to make predictions beyond those for which actual installations have provided data. They have learned, however, that microbes are only a tenth as hard to kill in the air as on the surfaces of food or dishes, and this suggests that many air-borne diseases can be controlled by ultra-violet sterilization.

Since the existence of the process has become known, bacteriologists have been clamoring for installations in their laboratories, to control air-borne contamination of samples and utensils. Poultry raisers have been experimenting in the control of chicken diseases by installing the lamps in hen houses. A large drug and cosmetic manufacturer has Sterilamps in his toothpaste mixer and over his unwrapped cold-cream jars. Theater owners have been writing to inquire whether the lamps could be installed to give patrons a free bath of germ-killing radiations as they enjoy the show. Sterilamps will probably soon be installed in household refrigerators, in the kitchen, and in the dish cabinet, to prevent the spread of colds and other maladies through the family. This slender tube, with its faint bluish glow and its unseen ultra-violet radiation may soon, indeed, be a familiar and healthful landmark on the domestic scene.

Some Astronomical Finds

The Best Fish are Not Always Caught by the Best Equipped Fishermen . . . The Little Fellow With a Small Telescope Makes Finds of Unusual Interest

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE old proverb that there are as good fish in the sea as ever were caught still holds true for the astronomical observer. He does not have to look back regretfully to some golden age in the past, when noteworthy discoveries were made, and lament that only routine work and drudgery remain for his portion. The industrious observer is still rewarded, now and then, by coming upon something unusual and remarkable. Several good finds of this sort, which have recently been announced, are worth recording here.

First we may pick a report by an Austrian observer—Lause, of Innsbruck. His equipment, as he describes it in a sentence, is not calculated to arouse the envy of others—a small telescope, set up in the open air with no fixed mounting, no driving-clock, no photometer, and an unfavorable climate. But this modest equipment is sufficient for the study of variable stars, by the familiar method of eye estimates, and Herr Lause has devoted his time to the useful, but not always easy, task of determining the periods of eclipsing variables.

Since the eclipses follow one another at intervals equal to the orbital period, it would be very easy to find this if one could observe under ideal conditions. But, if one eclipse is observable, the next is only too likely to come in the daytime, or when the star has set, or in bad weather, and many revolutions may elapse before another eclipse is actually seen. If the two eclipses have been well observed, so that the time of the middle of each is known within a few minutes, the true period should be some exact sub-multiple of this interval. What fraction it is can be found out only by following the star till more eclipses are observed. Then, when we have three or four separate time-intervals, each of which should be an exact multiple of the period, an answer can ordinarily be obtained. Simple arithmetical methods of the trial-and-error type are usually quicker than elaborate algebra.

ONCE in a while, however, there is trouble. For the star now in question, DI Herculis, Lause had a dozen observations of eclipse, but could not find a period to fit them. Finally when seven more eclipses had been observed (by patient watching, never knowing when to expect them) the puzzle was solved. There were two sets of eclipses. Those of each set came at regular intervals of 10.5502 days, but the eclipse of the second set came more than eight days after the preceding eclipse of the first set, and not quite 2½ days before the succeeding one. Until the two sets of eclipses were disentangled, it is no wonder there was confusion. The two sets of eclipses were independently discovered, and announced first, by Kordylewski.

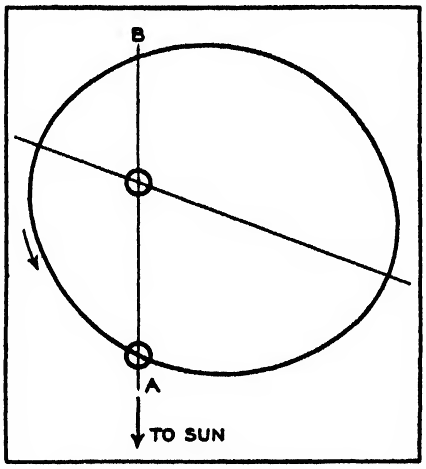


Figure 1: Eclipsing binaries

Readers familiar with eclipsing pairs will see at once what the two sets of eclipses mean. The pair consists of two stars of nearly equal brightness, revolving in a highly eccentric orbit, as shown in Figure 1. At position *A* on the orbit one star comes in front of the other and produces an eclipse of series I; at position *B* it goes behind and there is an eclipse of series II. The time taken from the first eclipse to the second is (by Kepler's Law) proportional to the area of the part of the ellipse on the right of the line *AB*, the interval until the following eclipse, to the part of the ellipse on the left of *AB*.

Lause finds that the principal eclipses (series I) are deeper than those of series II and last longer. The difference in duration is explained by assuming that the distance between the stars is greater at *A* than at *B*, and the orbital revolution consequently slower. The actual lengths of the eclipses are small, 0.36 and 0.26 days, and the losses of light 52 and 40 percent of the whole. It follows from this that the brighter star must give out at least 52 percent of the total light (since its eclipse, which may be partial, cuts off so much), and cannot possess more than 60 percent, even if the secondary minimum is a total eclipse; and it is not hard to show that the two stars must also be of roughly the same size. For a rough calculation we may assume them equal. We then find that the diameter of each is 11 percent of their average distance, and secure the scale-diagram of the system shown in Figure 1. The average density of the two stars can be calculated and comes out one-third of the sun's—a quite ordinary value.

TO put a scale of miles on the diagram, spectroscopic observations are necessary. As the star is of the eighth magnitude, these should be easy to obtain—and also precise photometric measures. The observers with big telescopes will presumably obtain these data within a few years; but the discovery of the remarkable nature and interest of the system will remain to the credit of the man with the small instrument.

Another eclipsing pair, of equal interest, has been studied by two Russian observers, Zverev and Kukarkin. This star, UX Ursae Majoris, was discovered—also in Russia—by Beljawsky in 1933. The present observers, in their first few nights' work, found strange behavior: "Sometimes the star would be almost invisible while the next observation, made after 20 or 30 minutes, would show the star in its normal brightness." It was soon found that there were regular eclipses occurring at intervals of $4^h\ 43^m\ 12^s.39$ but lasting only 40 minutes. Midway between the deep eclipses, in which 62 percent of the light is lost, occur shallow ones, with a loss of only 7 percent.

Apart from the short period, the light-curve of this system is quite of a stand-

ard type. There are two stars, revolving about their common center of gravity in circular orbits. One is ten times as bright as the other and about 10 percent larger in diameter, their radii being 21 and 23 percent of their distance apart. These elements represent the observations admirably and the conclusions appear to be well established. The remarkable one appears when the density is computed, for the results come out 20 times the sun's density for the bright star, and 11 times for the fainter one. These are much greater values than have ever before been found from a study of stellar eclipses. They show that here, for the first time, we have conclusive evidence of the existence of a star intermediate between ordinary stars and the vastly denser white dwarfs. The existence of such stars has long been suspected, for several white stars of spectral Class A are known, which, though probably nearly as hot as Sirius, are of only about the sun's brightness. Their spectra are somewhat peculiar, and it has been supposed that they were dense bodies. Now, in this case, the thing can be proved. The new variable is unfortunately very faint, of magnitude 12.7 at maximum. Photographs show that it is a white, and not a red star, but only the 100-inch telescope can photograph its spectrum. We may hope to hear from this ere long; meanwhile the "little man" may again be encouraged to hear that the observations on which the present important conclusions are based were made with a 7½-inch telescope, by the usual method of estimating the brightness of the variable with respect to a series of comparison stars. The magnitudes of these stars were carefully measured with a photometer by the same observers.

One more circumstance—perhaps the most curious of all—should be related. When the observers realized the remarkable character of the star, they wrote to the great Russian observatory at Simeis to ask whether it was shown upon their photographs. It was looked up, found on 71 exposures—and reported to show no variation! This must have been disconcerting to the visual observers. But when they had worked out an accurate period they found, that, as luck would have it, every one of the 71 photographs had been taken when the star was not undergoing eclipse. A diagram showing the phase of the variation for each exposure shows that they are scattered thickly over the whole period, with but a single gap—and in that gap, covering one eighth of the period, the eclipse happened. The chance that any observation made at random should miss the eclipse is ⅞. On ordinary principles of probability the chance that every one of 71 observations should miss it is $(7/8)^{71}$ or 1 in 13,000. The photographs were not actually taken at random, but as series of exposures on a few plates, at regular intervals. Whether this should modify the calculations of probability is a question for specialists, but it is evident that here we have a well-attested case where a very improbable event has actually happened. It may be recalled, however, that hundreds—probably thousands—of other variable stars have been similarly looked up on photographs, and no such case of missing every time has been recorded before.

Members of the Louisville Astronomical Society edging a 20-inch disk of Pyrex on their machine in quarters lent by the University of Louisville, Louisville, Kentucky. In the group are a gas chemist, a garage owner, a manual training instructor, a paint maker, a mathematics professor, a type-caster, a bridge engineer, and the treasurer of a glass company—typical combination of amateurs. The society meets weekly, discusses astronomy and telescopes, and will ultimately complete this telescope of 100-inch focal length which will then be used jointly by the University, the public, and the makers

Another interesting discovery, of a different sort, is reported from Stockholm. It came in the course of routine observations for stellar parallax. Among the stars on the working list was one of magnitude 11.6, with the considerable proper motion of 0″.95 per year. Measures of a series of photographs led to a parallax of 0″.089—putting the star at a distance of 36 light-years, and making its real brightness 1/400 of the sun's. All this is quite in the ordinary run; but an objective-prism photograph showed that the star had a spectrum of Class A—in other words, that it was a white dwarf. In luminosity and spectrum, this star resembles the companion of Sirius, and it is altogether probable that it, too, is of very small size and enormous density.

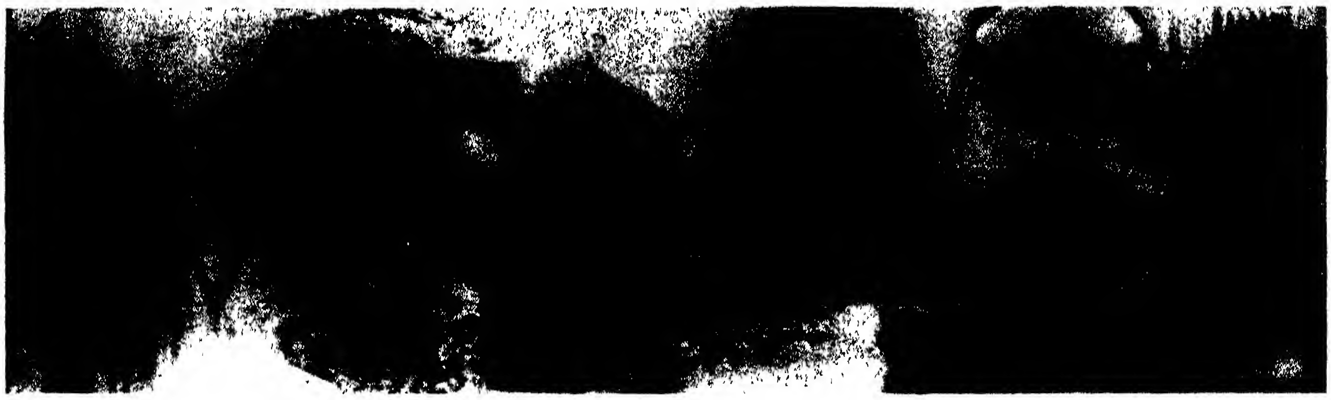
From the same observatory comes another discovery of the same sort, made by the same observer, Dr. Ramberg. Ever since Lewis Boss discovered the great moving cluster of the Hyades, in Taurus, and determined its distance, a search has been made for fainter members of the cluster. This is a straightforward piece of work, for the cluster stars move fully a second of arc in ten years and a displacement of this amount cannot possibly be missed when photographs taken at an interval of a decade or more are compared. A considerable number of faint cluster stars, discovered in this way by van Rhijn and Raimond, have been observed spectroscopically at Stockholm. Among these, Dr. Ramberg has found two, which though very faint, show spectra of Class A. What is more, they have the peculiar and very characteristic features distinctive of white dwarfs. The hydrogen lines are extremely wide and diffuse, and the spectrum is unusually strong in the ultra-violet.

This excellent work adds three more to the short list of white dwarfs previously known. The last two, like the first, are faint, giving out 1/250 and 1/350 of the sun's light. Visually, they are hardly brighter than the fourteenth magnitude.

The last two stars raise very interesting and puzzling problems. Their motion indicates clearly that they are members of the great Hyades cluster.

Now all the stars of this cluster are moving together through space and it is reasonable to believe that they have had a common origin, and hence to guess, at least, that they may be of about the same age. But there are stars of almost all kinds in this cluster—red giants, of great diameter, ordinary white stars, of moderate size, like Sirius, stars like Procyon or the sun, and fainter red dwarfs down to the limit of observation. We have good reason to believe that these ordinary stars derive their energy from the gradual transformation of hydrogen into other elements (See, Scientific American, July, 1937, pages 12-13), and have still a long life of luminosity before them. But the white dwarfs, with their enormous density, undoubtedly are throughout most of their substance very nearly in the degenerate state which marks the final stage of a star's history (so far as we can now understand it at all). They should not be in this state unless they had exhausted almost all their internal energy and lived through all but the final stages of their lives.

How they come to be members of the same cluster as ordinary stars, and presumably of the same age, is at present an unsolved problem. It is not quite new—Sirius and its companion present a similar case—but this additional discovery adds emphasis to a question which as yet no one can answer.—*Princeton University Observatory, March 25, 1938.*



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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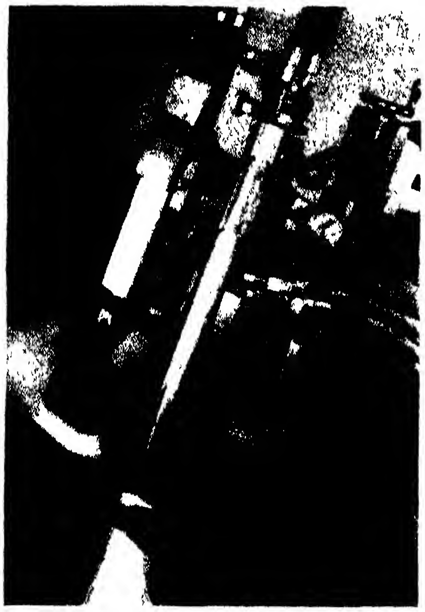
Flame Softening of Flame-Cut Steel

ALTHOUGH the vast majority of steels may be flame-cut without any detrimental effect, there are a number of the hard grades of steel, particularly the low-alloy, high-strength steels, which tend to harden along the cut edge following the cutting operation.



Flame following flame

A new process, known as flame softening, provides a simple and economical means for removing this undesirable hardness. Multi-flame heating heads, which usually operate simultaneously with cutting, furnish additional heat to the body of the metal so that the cut edge is either annealed or tempered, depending on the type of steel. In the accompanying illustration, one-inch thick, low-alloy, structural steel plate is being softened following cutting by means of a 30-flame heating head.

Vitamins in Fish

VITAMINS A and D are supplied by the oil of fish livers. However, recent investigations in Norway have shown that the oil in the bodies of the fish also contains desirable amounts of these valuable materials. Brisling have been found—even after smoking, canning, and storing—to contain 90 to 960 international units of vitamin A and 1000 to 3000 international units of vitamin D per 100 grams. Herring similarly contain both vitamin A and vitamin D even after kippering and canning. The proportion of vitamin in the fish body oils is only about 1/10 of that in the liver oils, but nevertheless has a considerable value.—*D. H. K.*

LAMPS

THE United States uses 50,000,000 60-watt lamps a year. Five years ago they cost 20 cents each; now they cost 15 cents. Because they give 15 percent more light, they give us, free, over 16½ million dollars' worth of electricity.

As Others See Us

UNDER the caption, "Just Foolishness," the London, England, *Sphere* recently made this comment: "The United States contains 6 percent of the world's area and 7 percent of its population. It normally consumes 48 percent of the world's coffee, 53 percent of its tin, 56 percent of its rubber, 21 percent of its sugar, 72 percent of its silk, 36 percent of its coal, 42 percent of its pig iron, 47 percent of its copper, and 60 percent of its crude petroleum.

"The United States operates 60 percent of the world's telephone and telegraph facilities, owns 80 percent of the motor cars in use, operates 33 percent of the railroads. It produces 70 percent of the oil, 60 percent of the wheat and cotton, 50 percent of the copper and pig iron, and 40 percent of the lead and coal output of the globe.

"The United States possesses almost $11,000,000,000 in gold, or nearly half of the world's monetary metal. It has two thirds of civilization's banking resources. The purchasing power of the population is greater than that of the 500,000,000 people in Europe, and much larger than that of the more than a billion Asiatics.

"Responsible leadership which cannot translate such a bulging economy into assured prosperity is destitute of capacity. But pompous statesmen, looking over the estate, solemnly declare that the methods by which it was created are all wrong, ought to be abandoned, must be discarded; that the time has come to substitute political management for individual initiative and supervision.

"There is only one way to characterize that proposal, . . . it is just damn foolishness."

"Bliffy Sniffer"

PERHAPS you have wondered how telephone men are able to find the right wire among the hundreds which fan out like straws in a broom from the end of a telephone cable. For years it was a tedious task. But Bell System engineers have recently brought forth the "bliffy sniffer," shown in use, in the accompanying illustration, by a cable splicer.

You can see that this "bliffy" is not a hound dog with supersensitive nose; it can't bark, bite, see, or smell. But it can hear

How "bliffy" does its "sniffing"

and, in a jiffy, sniff out the proper wire in a cable. Thus when cable is being installed, or when repairs are made, the voice service can be extended or restored much more easily and quickly.

The "bliffy" is really an "exploring amplifier," consisting of a box containing an amplifying set, a head-phone, which is worn by the splicer, and an instrument shaped like a pencil, which he holds in his hand, and which does the sniffing.

When repairs are to be made, a tone is sent out from the distant central office along the wire in question. The repairman clamps the "bliffy" telephone on his head and passes this pencil-shaped detector over the bundle of wires. Without any metallic contact, it picks up the tone, identifying at once the wire he wishes to reach.

Radio Warning at Railroad Crossing

A NEW device invented jointly by J. Edwin Smith, formerly railway claims attorney, and Leroy M. E. Clausing, radio consultant, to prevent accidents at railway grade crossings, has just passed a successful test with a perfect score.

The device consists of an automobile radio receiver which performs the dual service of warning the automobile driver of an approaching train and furnishing the usual broadcast programs.

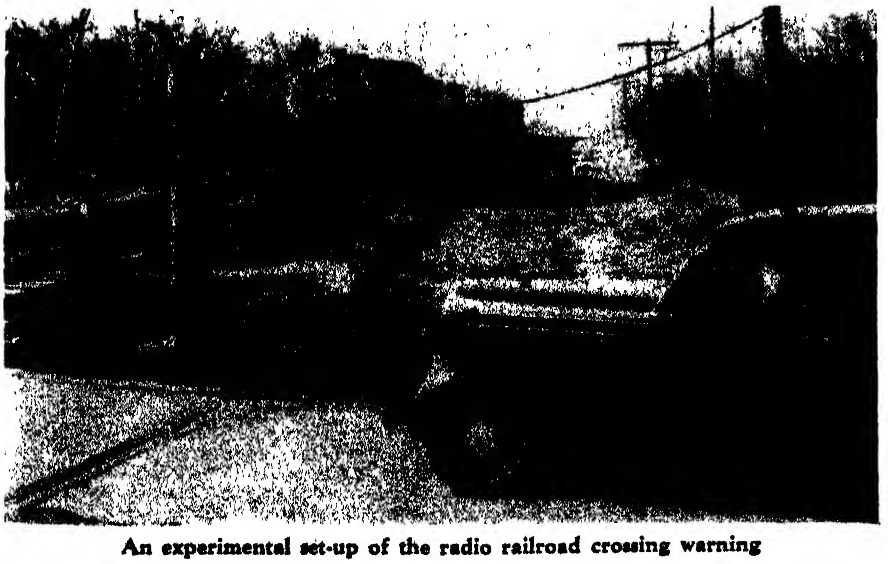
The warning signal is emitted by a small compact transmitter, located at the grade crossing and actuated by approaching trains, as are the warning bells and gates. The transmitter is designed to minimize the radiation field, so that the range is limited to a short distance of about 100 feet from the antenna. The latter is strung along the road for about one quarter mile on each side of the crossing, so that the driver has ample time to stop the car, regardless of speed.

The portion of the receiver used for amplifying the warning signal is automatically turned on when the car is started. Reception of broadcast signals is optional at all times but they are automatically shut off or blocked out by the warning signal from an approaching train, so that the unmistakable warning tone commands instant attention. A distinct and different tone is emitted for trains moving in opposite directions on double tracks to prevent drivers from crossing the tracks just after one train has passed and another is approaching from the opposite direction.

When baby cries, a sensitive microphone (right) transmits the sound to the distant reproducer shown above

The price of the improved auto radio will be practically the same as that of an ordinary auto radio and the cost of the small low power transmitters at the crossings is also very low, so that the item of cost can not stop the immediate installation of positive protection, by the railroad companies, bus companies, trucking companies, and privately owned automobiles.

It is estimated that at least 95 percent of the 4484 grade crossing accidents, with a toll of 1875 deaths and 5136 injuries in 1937, could have been prevented, had such an invention been in operation during that period.



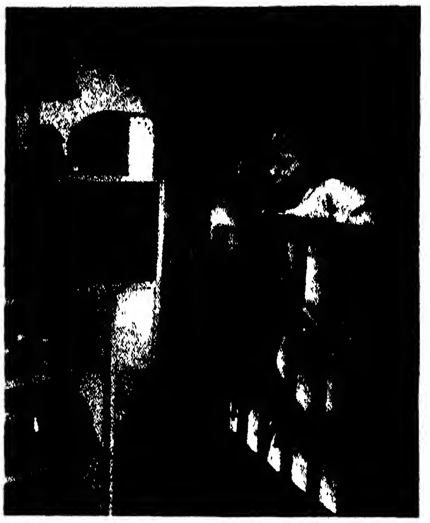
An experimental set-up of the radio railroad crossing warning

Radio Nurse

NO, it won't change the baby! That fact was made clear at a recent demonstration of the much-talked-of "Radio Nurse," a development of Zenith Radio Corporation.

It is in reality an extremely sensitive sound-transmitting device consisting of two small units—one a "guardian ear" which picks up even the slightest sound in the room in which it is placed and transmits it, highly amplified, to the other unit which may be placed in any other room in the house. Both units are put into operation by simply plugging them into an ordinary light socket, no special wired connection between the two being necessary, thus allowing the units to be moved from room to room as needed.

The principal uses for the new device are expected to be in the care of children and



invalids, although it also has possibilities as a burglar alarm, not to mention scientific eavesdropping.

During the demonstration, the demonstrator put his pocket watch near the "ear." Over the "Nurse" it sounded like the clank of a railroad spike. The fizz of a lithia tablet in a glass of water sounded like a cataract.

STEEL

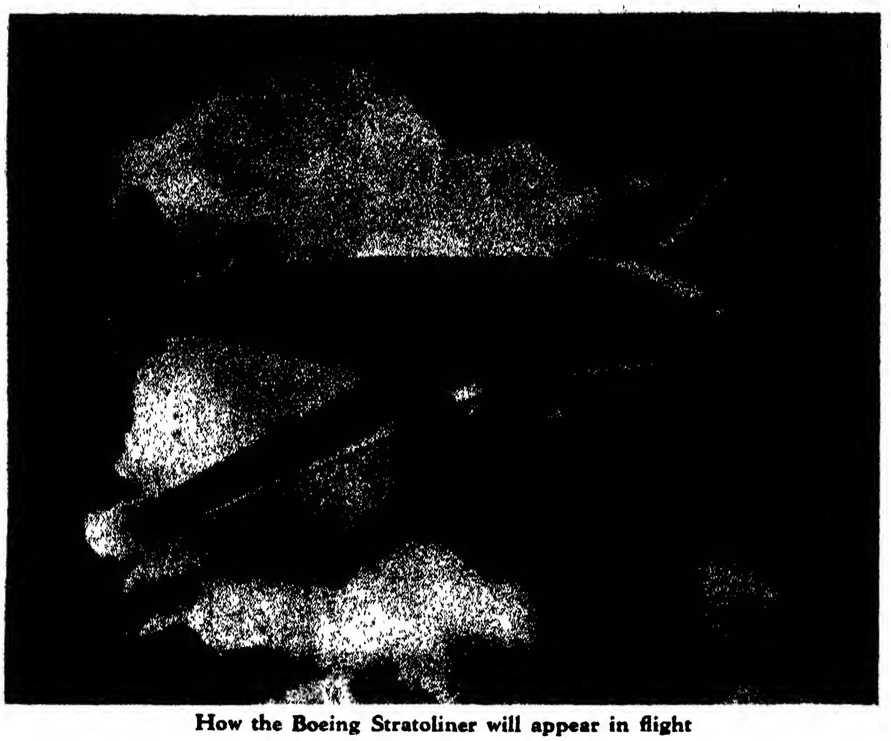
IN the typical small house, an average of four tons of steel and iron are used. This is in the form of nails, bath tubs, sinks, radiators, steam piping, furnaces, flashing, leaders and gutters, conduit, and the like.

Fireproof Fabrics By Simple Home Process

FABRICS can be fireproofed and made safer for clothing and house furnishings by a simple and inexpensive home process of dipping them in a colorless liquid, a solution of seven ounces of borax and three ounces of boric acid in two quarts of hot water. This treatment, says Dr. Martin Leatherman, of the Bureau of Chemistry and Soils, United States Department of Agriculture, will not protect fabrics from injury by flame or intense heat, but it will prevent the fabric from bursting into flame, and spreading fires that endanger life or cause the destruction of homes.

The borax-boric acid solution may be applied by dipping fabrics until they are thoroughly moistened, then wringing out the excess and allowing them to dry. Treated cloth may be ironed just before it is dry. Or the solution may be applied by sprinkling or spraying the fabric enough to moisten it. This method is likely to be more convenient for rugs, draperies, and upholstered articles. Addition of a little soap will make the treatment more effective for canvas and other textiles that do not wet easily.

Fireproofed fabrics are particularly de-



How the Boeing Stratoliner will appear in flight

sirable for curtains and hangings in the home which are likely to be blown against lamps or candles, for the coverings of ironing boards, for rugs near fireplaces, and even for children's playsuits. The solution is not weatherproof, and articles that are washed, such as curtains and playsuits, will have to be fireproofed after each washing. The treatment does not affect the textile colors and does not injure the fabric. It does have a slight protective effect in counteracting the destructive effect of acid and sulfur fumes from stoves and furnaces. Its most desirable feature is its ease of application.

The Boeing Strato-liner

THE problems of the supercharged passenger cabin for sub-stratosphere use have quite frequently been referred to in these columns. The first ship actually flown with a supercharged cabin is the twin-engined Lockheed, delivered for experimental purposes to the Army Air Corps. In a few months the Boeing Company will have completed a supercharged cabin ship for scheduled transport of passengers. Very appropriately this new plane will be called the Boeing Stratoliner.

The synthetic photograph of the Stratoliner is a true and accurate portrayal of the plane as it will appear in flight. Our readers have become accustomed to the extremely "clean" aerodynamic appearance of modern transports. Here the process of streamlining is carried a step further and the nose itself is perfectly streamlined, with the cockpit windows embedded in the bow of the fuselage. The elongated "tear drop" shape is entirely desirable from an aerodynamic point of view, and will not interfere with the pilot's vision in the slightest degree. Without definite information, we will hazard the guess that the windows will be of plastic, transparent material. It is difficult if not impossible to give glass the compound curvatures required.

The main items of the specifications of the Stratoliner are: Wing area, 1486 square feet; wing span, 107 feet 3 inches; length, 74 feet 4 inches; over-all height, 17 feet 3 inches; day passengers, 33; night passengers (16 berths, 9 reclining chairs), 25; cargo, 4000 pounds; fuel capacity, 1275 gallons; power plant, four Wright Cyclones of 1100 horsepower each; top speed, 241 miles an hour at 6000 feet; maximum range with 7000 pounds pay load, at optimum cruising speed of 150 miles per hour, 1950 miles.

But the fine design is not the most interesting feature of the new ship. Maximum interest attaches to the interior arrangements and the maintenance of reasonable pressures within the cabin. These interior arrangements are shown in the cut-away sketch. Just aft of the control room, in the nose of the fuselage, is the men's dressing room; then there are four spacious compartments, the first two shown made up for night travel. On the near side of the cabin are nine reclining chairs made up for night travel. At the rear are the women's dressing room and the galley.

The cylindrical walls of the cabin, including windows, doors, and fittings through which pass the controls, are absolutely airtight and constructed to withstand an interior pressure six pounds per square inch higher than the outer air. When the plane is flying at 20,000 feet, the cabin atmosphere will be equivalent to normal atmosphere at 12,200 feet altitude, which is sufficiently comfortable. When the plane is at 14,700 feet the interior "altitude" will be 8000 feet. Thus the cabin is not actually supercharged to sea-level pressure.

Fresh air, drawn through the leading edge of each wing, is compressed by two engine-driven superchargers and circulated throughout the cabin after being heated by condenser type steam radiators. Either of the two fully independent sets of supercharging and heating units will be able to handle the entire job alone, so that there is little risk of failure. The entire system operates automatically with the same ease as the thermostatic control of an air-conditioned home. The blowers furnish sufficient air for 40 passengers. There are individually controlled ventilators. Spent air is discharged through the baggage compartment housed below the passenger compartment.

Of course this marvel of the engineering art will be taken completely for granted by the public when put into operation!—*A. K.*

Revival of the Airship?

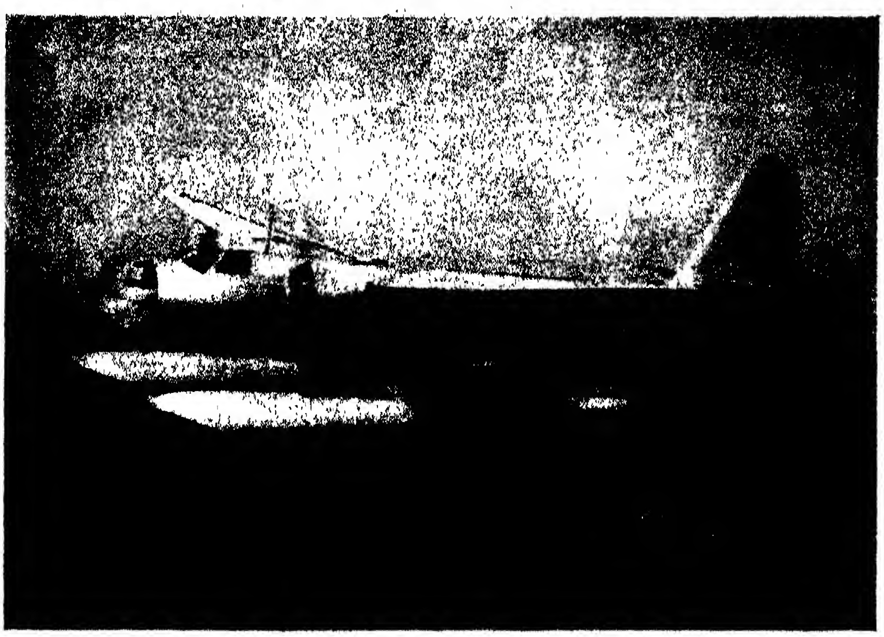
THE Navy is to have an experimental fund of 15,000,000 dollars for the development of aircraft and of novel surface vessels. In spite of the somewhat lukewarm attitude of the Bureau of Aeronautics, the House Naval Affairs Committee has decided to allot 3,000,000 dollars of this fund to the construction of a rigid airship of about half the size of the *Akron* or the *Macon*. The new airship will be used merely for training or experimental work. Certainly this is a wiser policy than again building the very largest

Cut-away drawing showing the interior arrangement of the Stratoliner cabin

of craft before further practical information is available for the avoidance of future tragic accidents.

Another sign of the revival of rigid airship activity is the forthcoming completion of the *LZ-130*, sister ship of the ill-fated *Hindenburg*. With indomitable courage the Germans are pushing their plans for the re-establishment this summer of their lighter-than-air service across the Atlantic. Trial flights will come in May. As soon as the tests are completed, a schedule of 15 to 18 round trips will be started at the average rate of three a month until fall. The *LZ-130* is almost identical in dimensions and general appearance with the *Hindenburg*, with the same cubic capacity of 7,000,000 cubic feet. Because it is planned to use helium instead of the inflammable hydrogen, the *LZ-130* will carry only 40 passengers against the 70 of the previous craft.—*A. K.* [At press time, above arrangements are in abeyance awaiting decision on the sale of helium to Germany.—*Editor.*]

A Navy Torpedo Boat



XPTBH-2, carefully designed from a fighting point of view

THE Navy Bureau of Aeronautics quite rightly releases only the most meager information regarding its plane developments. So we are lucky to have even a short story to present on the XPTBH-2 torpedo plane built for the Navy by the Hall-Aluminum Aircraft Corporation. These mystic letters probably mean that this is an experimental ship, and a torpedo boat, with designation H-2, but the reader's guess is as good as ours.

Even without detailed specifications, it is quite clear that the Navy has gained a formidable naval weapon. With completely clear space between the two pontoons or floats, there is every facility for launching bombs or a torpedo. Each float is mounted on a single streamlined strut, and not only is clear space thus provided, but aerodynamic efficiency is also gained. A single "monospar" is provided in the cantilever wings, a type of construction which is novel in American practice, although frequently used in British construction. The streamlined supporting struts of the floats have a logical point of attachment to the single spar of the wings. Floats are divided into several water-tight compartments, adding to safety in the case of accidental damage.

The fuselage has been carefully designed from a fighting point of view, and is divided into six compartments housing the various service requirements such as nose gun turret, mid-ship and after gun compartments, and, in addition, pilot, mechanic, and radio cockpits. The wing span is 79 feet 4 inches; the over-all length is 55 feet 4⅜ inches. *A. K.*

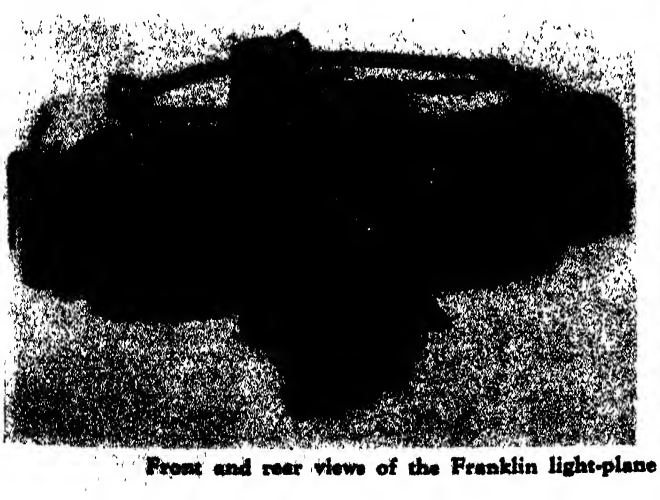
Engines for Light Planes

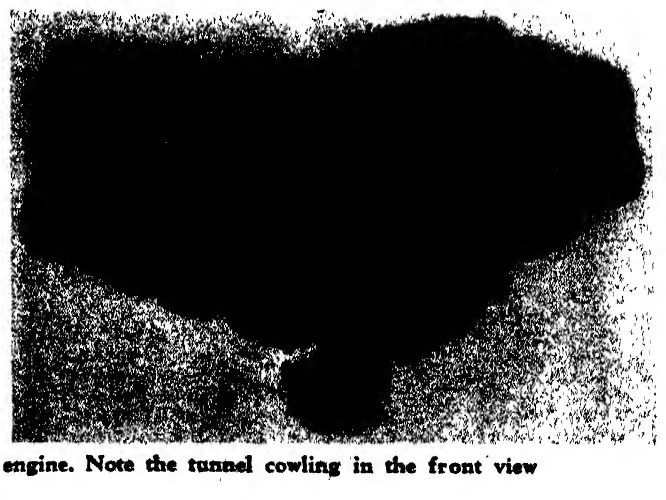
AMONG the excellent papers presented at the National Aeronautic Meeting of the Society of Automotive Engineers, a particularly timely one is that by N. N. Tilley, of Continental Motors, on engines for light airplanes. The light airplane has had a phenomenal growth in the last two years; further progress of the civil airplane type is bound to come with the development of better motors.

Mr. Tilley gave a fine definition of the light airplane: "It is characterized first of all by its light weight—about 600 pounds empty and 1000 pounds gross, which includes two occupants and ten or fifteen pounds of baggage. The type is simple and reliable. Landing speeds are below 40 miles per hour; cruising speeds are 70 to 90 miles per hour, and top speeds are from 85 to over 100 miles. Twenty-five or more miles are obtained per gallon of gasoline." Certainly this is a very attractive type, but one whose reliability and future are tied up with the provision of really suitable engines.

When light airplanes were first built, the power plant was unsatisfactory. Many of the original designs were based on standard automobile or motorcycle parts to obtain low prices. But it was soon found that continuous operation in the air presented far more difficulties than intermittent operation in earth-bound vehicles. Exhaust valve material had to be changed to the non-burning type used in larger aircraft engines. Crankcases had to be built of heat-treated alloys. Better spark plugs, better materials all around had to be substituted, and greater strength provided in various parts of the design. It is only today, after disappointment and evolution, that satisfactory light-plane engines have appeared on the market. We know of at least five engines in this category—Continental, Lycoming, Aeronca, Menasco, and Franklin.

From 35 to 45 horsepower, the recent light-plane engines have gone to more than 50 horsepower. In spite of higher revolutions per minute, these engines weigh from 155 to 165 pounds. The weight per horsepower is still high, three to four pounds per horsepower, which looks surprisingly heavy when compared with the one pound per horsepower of the large Wrights or Pratt & Whitneys. The extra weight is due in part to the fact that minimum casting thicknesses must be adhered to, and in part because the requirements of low cost minimize the amount





Front and rear views of the Franklin light-plane engine. Note the tunnel cowling in the front view

of machine finish and lead to the use of plain cast-iron cylinders, tappets, and camshafts.

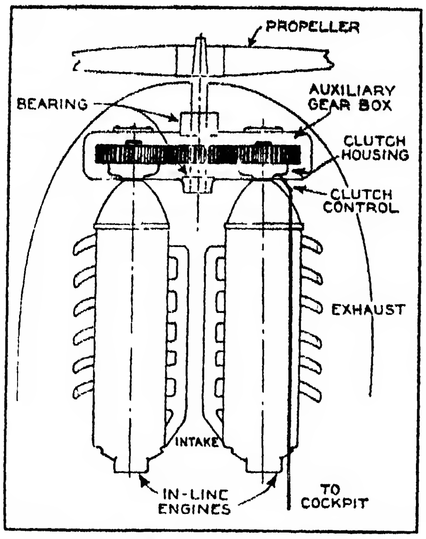
Cooling difficulties have been overcome by increasing the cooling fin area, and the use of tunnel cowlings. Balance difficulties have been eliminated by using four cylinders instead of two, and by arranging these cylinders in horizontally opposed fashion, which eliminates all the most important causes of unbalance. Higher revolutions per minute have made the weight per horsepower at least reasonable. Equipment has remained very simple, but is quite reliable.

Mr. Tilley is satisfied with the achievements, and it is not out of place to describe one of the several types mentioned above. This is the Franklin 50 horsepower four cylinder opposed engine, a derivative of the once well-known Franklin air-cooled automobile engine. As much as 53 horsepower is obtained at 2400 revolutions per minute. The cowling or tunnel was introduced to improve the cooling of the two rear cylinders. This cowling, and guidance of the air flow, now permit the rear cylinders to be kept at approximately the same temperature as the front cylinders. Fuel economy is excellent and lean mixtures can be employed. —*A. K.*

Unitwin Power

THE idea of a multiple-engine power plant driving a single large propeller is by no means new. The Germans tried such combinations, during the war, on some bombers (considered giants at that time) of long range. In fact, we recall that a German bomber actually had four engines mounted together in the nose of the fuselage and driving a single propeller. Gearing and clutches allowed all or any of the motors to be connected to the airscrew. Now the Lockheed Aircraft Corporation and the Menasco Manufacturing Company are co-operating in a power plant to which has been given the picturesque title of "Unitwin." Two Menasco models, each of 250 horsepower, are employed and these are connected to the propeller after the fashion shown in our sketch, although we have no information that this is indeed the method employed, and are merely offering a possibility.

The purpose of such a combination is obvious. The safety of twin engine operation is obtained without the disadvantages. When one motor fails in a normal twin-engine design, there is always an offset torque, which,



Two engines—one propeller

introduced suddenly, may give control difficulties. Also, the offset torque and the idle propeller increase drag and militate against continued flight on one engine.

Of course Unitwin introduces its own difficulties such as gearing weight and losses, use of clutches with accompanying complications, and placing of the engines in the nose where their noise and exhaust are more of a problem than when the engines are disposed on the wings.—*A. K.*

A Mechanical "Alligator"

THE mechanical "Alligator" recently invented and developed by Mr. Donald Roebling, of Clearwater, Florida, is a unique amphibion vehicle that propels itself as readily on water, through swamps, and up hill and down dale, as on firm flat land. Donald's father, Mr. John A. Roebling, having helped the Florida Red Cross relief work in the Okeechobee Lake region, asked Donald, in 1933, to build for him an amphibion rescue machine to assist in this work when needed. Thus it was that the machine came to be developed.

The structure is built of duralumin, a metal that is three times as resilient as steel, and yet has only a third of its weight. The machine has a total net weight of 8700 pounds, and has capacity to accommodate 40 people in its passenger section, which might add as much as three tons to the load. When on rescue work, the "Alligator" would carry a crew of from two to five men, and be equipped with a portable radio set.

One of the interesting features of this amphibion is the fact that the same method is used for propelling it on land and on water; in other words, there is no special propeller for operating the machine in the water. The two continuous treads at the sides of the machine are made up with specially-constructed Link-Belt double-width finished steel roller chain to which curved blades or cleats are attached.

The engine—an 85 horsepower Ford V-8 engine, with Federal-Mogul copper heads to give it a 120 horsepower rating—is located in the rear of the machine. The operator sits at the controls in the cab at the front of the machine. There are two hand levers and a Bendix electric vacuum control system, popularly known as an "electric hand." All clutches and brakes are operated hydraulically.

The speed of this machine, which measures 20 feet long by 8 feet wide over-all, is about 18 miles an hour on land, and 8.6 miles an hour in water.

Mr. Roebling points out that this amphibion could be used for other purposes as well, such as exploring swampy or thickly-wooded sections in the oil fields.

It could travel on ice and snow if proper precautions are taken to prevent formation of ice on the chain.—*Link-Belt News.*

BRIGHT

THE flare-up of the 16th supernova of all history, which was discovered last year by astronomers of Palomar Mountain observatory, was of the order of 500,000,000 suns in brilliance. So distant is the star that its light took 3,000,000 years to reach the earth.

A New Zeolite

IN treating hard water the usual methods of softening leave sodium instead of calcium and magnesium in solution. Water softened in the usual manner is often not suitable for use in making ice. A new material having an action similar to the zeolites, but introducing hydrogen into the water instead of sodium, has recently proved

The mechanical "Alligator" is as much at home on land as in the water. It was designed for rescue work

efficacious. In principle the new material, Zeo-Karb H, has the property of taking sodium ions out of the solution and replacing them by hydrogen. Thus a water containing sodium carbonate, after usual softening treatment, will lose its sodium content when passed over a bed of the new material. The water after this treatment is practically free from dissolved metals of any kind.—*D. H. K.*

America Led

FROM time to time during the past year or two reports have been published concerning work in Russia in the use of preserved blood from suicides as a source for transfusion. So often has this been commented on in various publications that many have been led to believe this technique is uniquely Russian. However, it is considerably older than many may believe. For example, the *British Medical Journal* for June 22, 1918, the final year of the World War, contains a paper describing the same technique, written by Capt. Oswald Robertson, an American Army surgeon serving at that time with the British Expeditionary Forces in France. He discussed the use of blood in this manner, and states that 22 transfusions of bottled blood obtained from the dead were made on 20 individuals, 11 of whom survived.

Even then, the technique was not new. Dr. Robertson, in his 1918 article, gives credit to Drs. Payton Rous and J. R. Turner of the Rockefeller Medical Institute for still earlier experiments on this technique.

Do Your Own Sound Recording

BUSINESSES, schools, sales executives, music teachers, and many others have long desired some method of recording the vocal or instrumental efforts of their members, their sales forces, or students. Such a method is now available in the Presto Junior Sound Recorder, a new and highly perfected home recording instrument. It makes phonograph records of the speaking voice, of singing, orchestra music, of sales solicitations, or of conversations which must be preserved.

This recorder consists of a 12-inch recording turntable, a recording mechanism that cuts the groove in the record as it records the sound, a play-back pickup, a five-tube amplifier having ample power for home use, a loudspeaker, and a microphone with desk stand. The entire instrument is mounted in a carrying case of moderate size and weighs

Sound recorder—compact

35 pounds. Operation is simple; it is necessary only to plug it into a 110-volt alternating circuit. A converter may be obtained for using it on 110-volt direct current or on storage batteries.

The records used are mirror smooth, cellulose coated disks, the same as are used by leading broadcasting stations for making electrical transcriptions. Once made the record is permanent and may be played as often as desired, using ordinary steel needles.

***Above:* Tracing contour lines by the new stereoscopic method, using colored glasses. *Below:* Printer and one of the small glass plates**

RAINBOW IN METALS

ELECTROPLATING has progressed to the point where it can duplicate the rainbow or the color in a soap bubble. By super-imposing a film of copper oxide on bright nickel plate as a base, any color in the rainbow can be reproduced in metal, the color being determined by the refraction of light which varies with the thickness of the film.

Stereoscopic Map and Contour Plotter

THE United States Army Air Corps is reducing 13-square-mile chunks of countryside to little glass plates the size of two and a half special delivery stamps.

Bausch and Lomb Optical Company is now completing for the army fliers a chain of instruments that appear to make the high-booted surveyor with transit and theodolite as extinct as the dodo. Where earthbound surveyors, like George Washington, took days and weeks for field work, the new technique uses an airplane and does the work in a few minutes.

It is not so easy as it sounds, according to the engineers who designed the instruments. A map traced from a simple aerial photograph is not very useful in placing artillery, planning dams, or putting through power lines. For such purposes knowledge of the vertical lay of the land is as necessary as north-south and east-west data.

To measure heights and depths of all the little hills and valleys 20,000 feet beneath a plane cruising at 150 miles an hour, the new Stereo-Mapping Projector equipment uses the same principle as three-dimensional movies viewed through spectacles with one red and one blue lens.

An automatic camera in the plane, shooting at regular intervals, makes pictures a mile apart. Terrain features are thus seen from different positions in succeeding photos just as the two eyes see things from slightly different positions to get depth perception. If the two eyes respectively see the views taken a mile apart, the effect is as if the map-maker had eyes a mile apart.

To achieve this, the seven by nine inch film negatives, each covering, from the usual altitude of 20,000 feet, about 13 square miles, are printed on small glass plates. From them the picture is projected down on a drafting table by two adjacent projectors operating with red and blue light respectively. An observer who looks at the projected overlapping pictures with red and blue spectacles sees with one eye only what the camera saw in the first position and with the other eye only what the camera saw in the other position.

With six separate adjustments on each projector set to bring it into exactly the same angular position that the camera had when it made the corresponding negative, the mapper suddenly sees a single illusory three-dimensional model of the terrain on the table before him. So realistic is it that he may feel an impulse to pat the top of a smooth hill or try to prick his finger on a telephone pole.

To draw his map he moves about on the drawing paper a fixture containing an illu-

minated pinhole mounted directly above a pencil. With the point of light set at a given height, the mapmaker moves the fixture about so as to keep the point in contact with the surface of the illusory ground. The line thus traced passes through all points where the ground is that high. Such a series of lines create a contour map.

With the great reduction in size involved, the highest accuracy must be maintained to make usable maps. A few thousandths of an inch of error may mean many feet in the field.

"Rapid-fire" X-ray equipment for tracking down tuberculosis

Synthetic Hard Materials

DESPITE the age-long search for hard materials to make tools and abrasives, nothing has been made or found that compares with the diamond in hardness and efficiency as a cutting tool. Although synthetic silicon carbide is harder than other natural materials, and boron carbide recently developed as a commercial abrasive is harder than silicon carbide, both are easily cut with diamonds. A cheap material that is closer to diamond's hardness is being continually sought.—*D. H. K.*

Stream Sedimentation Studies Provide Valuable Data

A LABORATORY designed to test the sediment-load of streams has been built by the Works Progress Administration of North Carolina across Rocky Creek in Iredell County for the United States Department of Agriculture. Sedimentation studies will be the aim of the Soil Conservation Service work at this station.

Spanning the stream, 14 concrete veins spaced five feet apart adjoin concrete and stone revetments. Four feet below each section is a 16-inch pipe, leading to a pump house. Hydraulic oil cylinders permit a sample of each or any vein to be pumped into the vats.

Qualitative and quantitative analysis of the samples will be made to determine from the suspended load what bed load of sediment is carried by the stream under all conditions.

North Carolina, immense developer of water power, has a vital interest in the experiments which aim to find out how to prevent depletion of reservoir capacity; to determine the life of a reservoir by finding out exactly what went into it after each rain; the relationship between the sediment load and hydraulic functions of a stream; how much damage is being done to land on a particular watershed and how much would be justifiable to spend in a particular section to control soil erosion and the best method to adopt for that purpose; conservation of navigability of streams; and the prevention of flood damage.

Similar devices are being installed at Greenville, South Carolina, and Dadeville, Alabama.

Full-size set-up for studying stream sedimentation

The Dragnet for Tuberculosis

THE movement for X-raying youths in school, at the most susceptible age for the development of pulmonary tuberculosis, which was reported in this magazine in November, 1933 (page 215) has subsequently gained strength. While there is nothing especially novel in the use of the X rays themselves, the novelty connected with the routine work described at that time lies in its speed and cheapness. Long rolls of relatively inexpensive sensitized paper, instead of the usual X-ray film, are employed, and hundreds of youths can be X-rayed in the school building in a single day. The method, therefore, is essentially a dragnet to catch cases of tuberculosis while they are in an early stage, and not only makes the disease known to the youths who have it, but forestalls potential reservoirs of germ infection from going about, for several years as often happens, without knowledge.

In many schools this kind of routine search for early cases is now an accepted method and future generations will reap the benefit, not alone in terms of the sufferings saved to the patient but also in terms of economics—dollars and cents saved to the community in various ways.

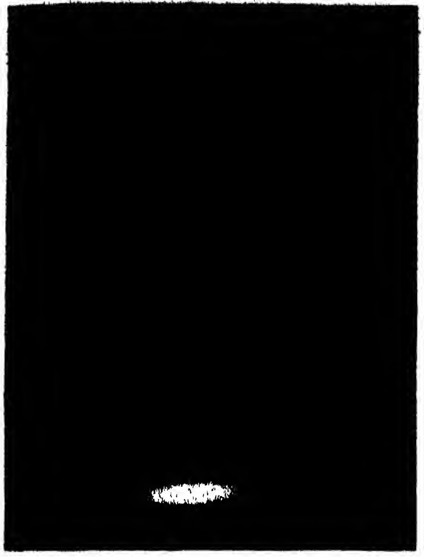
It seems certain that this kind of approach to the tuberculosis situation will spread, and if it spreads more rapidly than the germs of the disease, it will be all to the good.

Since the beginning of the present century the death rate from tuberculosis has been reduced in the ratio of 201 to 56, thanks to various measures introduced by science. This remaining figure, 56, can and will be crowded down to 46, then 36 and 26, and so in time will be pretty nearly, if not quite, on its way out.

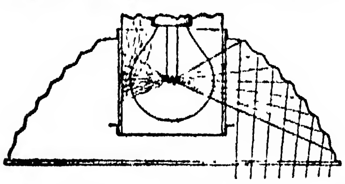
Dental Light with Less Heat

THOSE who have sat for hours under the heat of ordinary dental lights would find comfort under a new dental light developed by the Wilmot Castle Company. This light throws a spot susceptible of rather exact control, so that there is no need to light all the face. The most important feature is the great reduction of radiated heat.

An ordinary incandescent light bulb con-



Above: **How the new dental light focuses its rays to a concentrated beam.** ***Below:*** **A heat filter is between the light and the reflector**



verts electrical energy into a very long spectrum of radiant energy. This radiant energy is not heat in the sense of molecular vibration, but is of the same character as visible light and can be reflected in the same manner. Hence if it is not blocked before reaching the reflector it would be reflected and concentrated with the light beam. Blocking it before it reaches the reflector prevents it from being concentrated on the patient or dentist.

The heat-absorbing process employed in this new light is, therefore, a filter glass which will transmit the visible portion of the spectrum but will not transmit the longer wavelengths in the heat portion of the spectrum. This might be compared with the light-filtering action of a piece of colored glass, which simply transmits a certain portion of the visible spectrum and is opaque to the remaining portion.

The optical set-up of the lamp might roughly be defined as a series of narrow, circular reflectors designed at various focal lengths and with each reflector of such diameter that the lower base of one adjoins the upper base of the other. In this way, a non-critical focal point is obtained so that the distance between the lamp and the patient's mouth can be varied without shifting the bulb and reflector.

Upside-Down Dam

TAKING a lesson from Holland's conquest of the Zuyder Zee by pumping its perennial floods over the dykes, the Westinghouse company decided to protect its East Pittsburgh works along the banks of Turtle Creek by damming the valley against the backwater of the Monongahela River and then boosting the Turtle Creek flood over the top of the dam. This work was described during its initial stages in our January issue.

Recently this upside-down dam was completed and tested. One of the accompanying photographs shows its position under the George Westinghouse Bridge, Turtle Creek running into the picture from the left past the Westinghouse company's plant. Over the roadway is one of the gates and over the creek itself is another larger one, both to be lowered and sealed against leakage in the event of a major flood of the Monongahela which often floods the roadway in the foreground. In the structure directly behind the gates are three pumps, each powered by a 5000 horsepower electric motor and each possessing a 10-ton steel propeller to force the water from Turtle Creek over the dam into the Monongahela. The water outlets on the down-stream side of the dam are shown in the right foreground.

Non-Glare Auto Headlights; Patent Tangle Now Unravelled

HIGHLY important news for glare-blinded, night-driving motorists is contained in the recent announcement that the conflict over patent rights on the use of polarizing materials for automobile headlights has at last been cleared.

The Polaroid Corporation, manufacturers of sheet polarizing material which is finding wide applications, has acquired the basic patents of Dr. L. W. Chubb for the use of any polarizing material in headlights. Dr. Chubb is director of research of the Westinghouse Electric and Manufacturing Company, but the patents were those of Dr. Chubb personally.

Previously, the application of polarizing material in headlights, to eliminate the hazardous glare at night, has been at an impasse. Dr. Chubb had the patents on the use of materials for this purpose and had demonstrated headlights so equipped. The trouble, in the past, was that the materials which could be used were highly expensive and such headlights would have cost as much as 100 dollars or more.

Edwin H. Land, young Boston scientist who formed the Polaroid Corporation, had invented the cheap, easy-to-make, sheet Polaroid material but was unable—because of the Chubb patents—to apply it to its most valuable use in automobile headlights.

The present pooling of Chubb and Land patents with control vested in the Polaroid Corporation was accomplished by a transference of stock to Dr. Chubb and his associates.

Polaroid was originally invented to solve the headlight problem but while the patent tangle was being unravelled it found wide use in sun glasses and photographic and scientific equipment.—*Science Service.*

One of the three 10-ton propellers built to detour Turtle Creek around the new upside-down dam described

CHICKENS

THERE has been a steady decline in chicken population on the farms in the United States. In January, the estimated total was 387,-251,000, which represented a decline of 7.9 percent compared with last year, a decline of 3.4 percent from 1936, and a decline of 0.7 percent under 1935.

Four-Wheel-Drive V-8

IF you want to drive a Ford V-8 through the sands of the Sahara, on construction jobs where traction is poor, through muddy ground or over soft earth hillocks, the Marmon-Herrington Company will transform a Ford V-8 into a four-wheel drive machine. With such driving, the roughest terrain may be easily negotiated. That company now of-

From left to right, the arrows point to the gate in the roadway, the gate over Turtle Creek, and the outlet on the down-stream side of the dam. See the text

fers a complete line of passenger and commercial cars with power and traction on all wheels.

This company also builds a complete line of heavy all-wheel-drive vehicles of tremendous power and tractive ability but claim that the all-wheel-drive Ford cars out-perform the heavier units in many respects. They are lighter, have greater maneuverability and speed, and easy steering.

PROGRESS

RESEARCH leading to greater progress takes an average of one cent out of each dollar made by industry and agriculture in this country. Industry spends about 1.7 percent of its income, while about 0.37 percent of what agriculture makes is spent for research.

REST IN BED FOR COLDS

REST in bed is the best treatment for respiratory diseases such as colds, bronchitis, sinus trouble, and "grippe," Dr. Arlie V. Bock of Harvard Medical School recently told the American College of Physicians, basing his opinion on results of this treatment which was given nearly 2000 Harvard students during the past three years, according to a *Science Service* report.

This common-sense treatment, he said, often saves time, trouble, and money in the end. Very few serious complications followed the colds and sore throats and similar ills when treated by simply putting the student to bed in the infirmary.

Dr. Bock advises against the use of sprays, ephedrine nose drops, painting the throat with argyrol or dyes, or packing the nose with adrenalin. He believes such "energetic local treatment" often prolongs the illness by irritating the membranes of nose and throat.

Among the few cases of pneumonia which developed in these students, the cause was found in many cases to be a virus rather than the pneumococcus which generally causes pneumonia.

Living under too great tension, both physically and nervously, is, Dr. Bock believes, an important factor in bringing on colds and similar ills. Since there is no specific remedy for these conditions, he advises that doctors teach themselves and their patients to "live within the resources of their physical and nervous systems."

IMPROVED TRANSPARENT RUBBER

A NEW form of magnesium carbonate, differing in crystalline structure from the conventional substance, which has the property of producing a greater transparency in rubber than forms previously available, is now being produced in the United States.

Heretofore the magnesium carbonates used in making translucent rubber were imported from abroad, but gross inequalities in the material increased costs, impaired quality, and led to the search for a compound to meet the standards of American manufacture.

Use of the new material, known as "Clear-carb," has resulted in rubber of greater trans-

parency, increased tensile strength and modulus, with a decrease in manufacturing cost. Twenty-five to forty parts per hundred parts of rubber are used in the mix. Its advantages in translucency are obtained through its physical structure. Clearcarb has a constant refractive index of 1.525, intentionally identical with that of pure vulcanized rubber. Under microscopic tests the crystalline structure of Clearcarb appears irregularly globular, whereas the usual magnesium carbonate exhibits crystals.

Rubber products compounded with the new material may be produced in colors at lower cost because their greater transparency permits the use of a smaller proportion of the expensive colors to get the desired shade. The natural color of rubber produced with Clearcarb is a clear, transparent amber.

Transparent rubber is used in, among other things, hot water bottles, gloves, nipples, crêpe soles and heels, and women's overshoes.—*D. H. K.*

Indium Makes Bearings Last Longer

INDIUM, a few years ago a chemical curiosity extracted with great difficulty from rare minerals, is now a full-fledged industrial metal, with an ever-expanding use as an alloying agent for bearing metals.

Motor bearings, resisting millions of revolutions during the life of a car, are now being made even tougher, C. F. Smart, General Motors Company engineer, reported recently, by plating the bearing surface with indium. This surface coating makes the bearing metal resistant to corrosion by the acid oils now in common use in motor cars.

Until recently, babbitt metal, an alloy of tin, antimony, and copper, was used for most high-speed bearings. Today, bearings are lined with silver-copper-cadmium, cadmium-nickel, and cadmium-zinc alloys, which are later electroplated with indium, increasing their resistance to oil corrosion.—*Science Service.*

HOSPITALIZATION

ONE out of every 14 persons in the United States occupied a hospital bed during 1937. He stayed 12.6 days, on an average.

Outlets for Slag

FIFTEEN million tons of blast furnace slag, once a useless by-product for which research has now found a definite commercial value, were produced by the steel industry in 1936, the American Iron and Steel Institute has estimated.

For years the makers of pig iron and steel were faced with the problem of disposing of the slag or cinder formed during the refining of iron and steel, and slag piles grew to such an extent that they covered thousands of acres of valuable land. Applied research, however, has revealed many practical uses for slag, although the tonnage of slag produced still exceeds the demand.

Crushed and screened blast furnace slag has been found useful as railroad ballast, concrete aggregate, road material, covering material for roofs, a filtering medium in sewage-treatment beds, and even as beds for

oyster culture. About 4,250,000 tons of such slag are commercialized annually, at an average value at producing points of approximately 90 cents per ton.

Another class of slag is granulated slag, prepared by forcing a stream of water or steam against the stream of molten slag emerging from the furnace. It is used as a component part of standard cement, as an insulation for concrete highways, in gas and water filtration, in highway and railroad embankments, in cement building blocks and as a soil corrective agent. Over two million tons of granulated slag, with a value of about 25 cents per ton, are marketed annually. Of this amount, an estimated 500,000 tons are used in cement manufacture, displacing limestone valued at approximately $1.50 per ton.

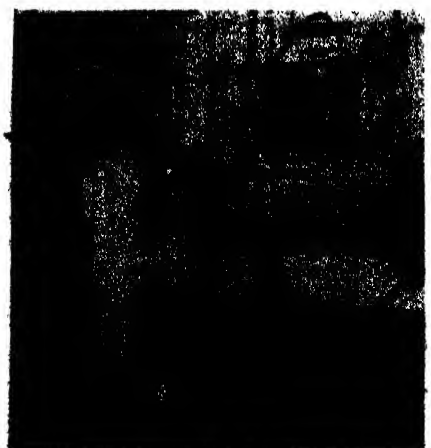
A relatively new use for blast furnace slag is in the form of "mineral wool," fine glass-like threads produced by blowing air into a stream of molten slag. Slag wool is used in industrial and home construction as an insulation against heat and cold. Upwards of 50,000 tons of slag were used for that purpose in 1937.

The slag produced in open hearth furnaces operated in the southern states has a high content of lime and phosphorus oxide, due to the nature of southern iron ores and production processes. Such slag, when finely ground, is a valuable conditioner for soils deficient in lime and phosphorus. It is estimated that 36,000 tons of southern open hearth slag were used for soil conditioning during 1936, and a total sale of 50,000 tons was estimated for 1937.

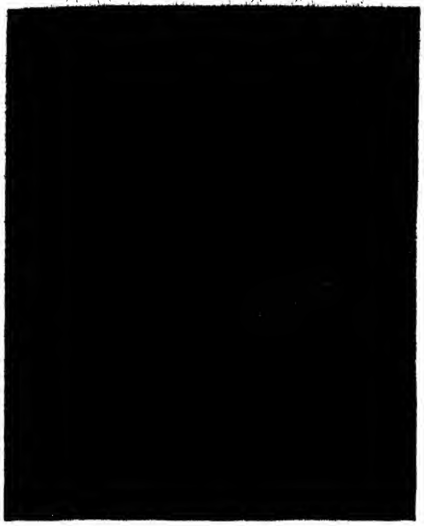
Windmill Power on Phone Line

POWER for transmitting telephone conversations across certain parts of the desert in the Southwest will be supplied by windmills, as a result of tests recently completed by engineers of the Bell Telephone Laboratories at Schooley's Mountain in northern New Jersey. The windmills will be installed on the "Fourth Transcontinental," new trunk route recently put in operation across New Mexico and Arizona. As this important line to the Pacific coast traverses wild country in spots, into which it is impracticable to run power lines, it has been necessary to provide some means of developing power on location.

The windmills drive generators which charge the batteries supplying current to



Experimental apparatus used in testing the wind-driven generators



Windmill on a 'phone line

vacuum tube amplifiers or "repeaters." On this particular route it has been necessary to install repeater stations at frequent intervals because of the new type of telephone channel being used—a "carrier current" system recently developed by the Bell Laboratories. This system, operating on frequencies ranging from 36,000 to 140,000 cycles, will provide 12 voice channels on a single pair of wires. In all, each pair of wires along this route will ultimately carry 16 conversations. [See "The 'Fourth Transcontinental,'" April 1938 Scientific American.—*Editor.*]

This is believed to be the first occasion in which wind-driven generators have been adapted for use on telephone lines. The experiments at Schooley's Mountain resulted in the development of apparatus with a number of automatic features, designed to keep the lines in operation under almost any conditions of operation at the desert stations. Records indicate that there is an almost constant breeze in that region, sufficient to keep the generator charging and yet not too violent. But should there be a prolonged flat calm or should the windmill be damaged, a gasoline-operated generator below the windmill will automatically start when the battery reaches a certain stage of depletion. Should this equipment fail to start, another automatic device will sound an alarm at the nearest "inhabited" repeater station, some 60 or 70 miles away.

Stainless Steel Tiles and Linings

STAINLESS steel will soon find scores of new uses in thousands of homes as a result of a development just announced by the Ludlum Steel Company. Most people know stainless steel and in one way or another enjoy its beauty and lasting permanence. A few years ago it came into common use for paring knives and kitchen cutlery. In recent years, stainless steel has been adopted for all manner of uses where sanitary, lustrous, permanently rust-proof finishes were desirable.

Engineers, aware that public interest and demand for stainless steel in the home were held back only by cost and difficulty of installation, long ago set to work on the problem; after many months of work and testing, they found the answer in Ludlite, an entirely new form of stainless steel.

Ludlite is a composite product. Its outer

surface is Silcrome—strong, thin, stainless steel. Its backing is a tough, flexible, non-metallic material. By a special manufacturing process, the stainless steel and the flexible backing are permanently bonded through heat and pressure.

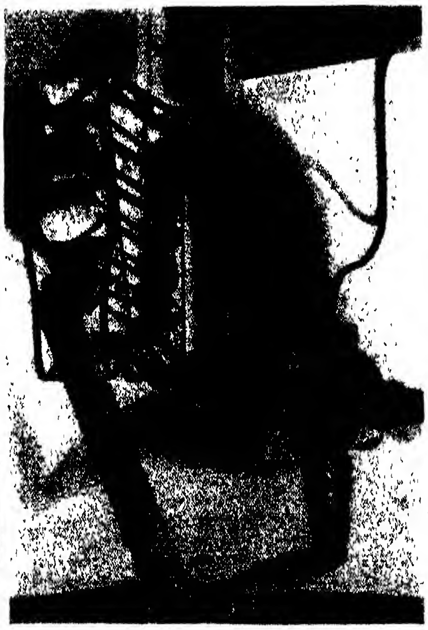
The backing material affords desirable support to the steel and makes it possible to cement the Ludlite to plaster, wood, fiberboard, concrete, and other surfaces. By this means, light gage steel can now be used; extreme flexibility and ease of application result; the flexible backing deadens sound.

The outstanding feature of this new material is the remarkable ease with which it can be installed. It can be cut right on the job with ordinary heavy scissors and can easily be shaped and cemented, nailed, or screwed in place. Attractive molding strip of stainless steel for finishing edges and intersecting surfaces is also available in all needed shapes and styles. Hence, it is a simple matter for the artisan, the home craftsman, or anyone handy with tools to use this material anywhere in the home.

Stainless steel shelves in pantries and kitchens are replacing wood, oil cloth, and linoleum. Sinks and drain boards together with back panels are blossoming out with easily applied Ludlite. Bathrooms are shining in Ludlite tile. Bins and boxes are being lined with stainless steel. Door push plates, fireplace screens, small table tops, trays, and wainscotings are taking on a luster that will last indefinitely.

Remote Control Hose Valve

HOSE valves can be of tremendous value in fire fighting but to prevent their freezing is frequently a serious problem. The new Rockwood remote control hose valve



Remote control for fire valve

eliminates this problem. There is no water in the exposed section of the piping. The control valve is located in a warm place. The controls are of two types—either a break-glass station is operated or the valve wheel is given a full turn. In either case an impulse is transmitted, and the valve operates and water is at the nozzle without delay.

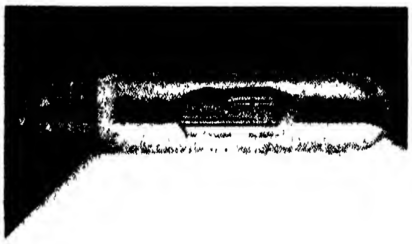
Where there is danger of freezing, the

use of this valve eliminates the necessity of insulating the piping. It has been used successfully with regular wet underground systems which have developed leaks, especially in cases where the cost of replacement was high because of the nature of the pavement. In such cases the piping is normally empty. The loss from leakage during fire service is not serious, whereas if the water is in the piping normally the leakage is tremendous in the course of a year.

The new Rockwood remote control hose valves are used in conjunction with a special main valve which controls the flow of water from the city water mains or other sources of water supply. This main valve is generally located where there is heat throughout the cold weather. The remote control valves themselves are located at various points throughout a property. Thus the piping between the main valve and the remote control hose valve is normally empty.

Tubular Reflection Light Bulb

A TUBULAR lamp, inside silvered, that serves as its own reflector, has just been introduced by the Birdseye Electric Company. The new lamp is side-silvered, and concentrates all the light in a powerful



The reflector is within

beam that makes an angle of 45 degrees with the horizontal, viewed from the side of the lamp, and one of 50 degrees viewed from the end. The reflecting surface, of real silver, is on the inside of the glass. Accurate adjustment of the beam is made possible by a special spring contact base; the lamp may be used in any medium base socket and burned in any position.

The new lamp is made in 25 and 40 watts. Lamps will be available in standard and color correction frostings and in a wide range of colors processed by fusing the color into the glass.

According to Clarence Birdseye, originator of quick-frozen foodstuffs, his new lamp is the first 25-watt tubular lamp in standard voltages to be inside-silvered; the first to be gas filled; and the first to employ a double coil filament.

Among the industrial and commercial applications of the new lamps are: individual machine and inspection-bench lighting; desk lamps; louvres, troughs, and panels; and for show and refrigerator cases.

Parts of Brain Removed Without Loss of Intelligence

LARGE portions of the important frontal lobes of the brain can be removed surgically without damage to the intelligence, it has been reported to the American

Psychological Association by Dr. D. O. Hebb, of the Montreal Neurological Institute and McGill University. Four cases were reported to the scientific meeting by Dr. Hebb, but the identity of the individuals was guarded with medical scrupulousness. All four have been given careful psychological examination after the serious brain operation, and in one case it was possible to compare the scores with results of an examination made before the surgery. In each case, the surgery was necessary because of disease conditions.

One man, after removal of the left frontal lobe of the brain, received a perfect score on a mental test for superior adults. This gave him an IQ of 152, putting him in the "gifted" class. The patient's success in his calling and in life fit in with the results of the mental test, Dr. Hebb reported. This man, as well as the three other cases reported, was right-handed, and therefore the left side of the brain was the dominant side. It has been previously supposed by many physicians that loss of a large part of the dominant side of this thinking area of the brain would mean loss of mental ability.

In another case, removal of between 4.5 and 7 percent of the whole cerebrum left the patient still above average in intelligence.

In a third case it was necessary to remove surgically more than 4 percent of the cerebrum and the disease condition had destroyed an even larger part of the brain. Yet this man's IQ was only one point lower after this serious loss than before the operation.

In the fourth case, after removal of the left frontal lobe, the patient appeared to relatives as of somewhat better intelligence than before. The only ascertainable defect in this man is a possible loss of initiative in business and society.—*Science Service.*

MOTHPROOFING

THE latest siege gun in the war against moths is an old device, the vacuum cleaner. By using it, together with an applicator made by General Electric, mothproofing compounds are forced into the fibers of any textile.

Soil-Less Agriculture At Home

INTEREST in growing plants without soil in chemical solutions has become so widespread that an Evanston, Illinois, company is prepared now to supply kits for chemical gardening at home.—*D. H. K.*

Fungus Lassos and Devours Animal Prey

A FUNGUS—a sort of fifth cousin to the common bread mold—that captures and eats small worms was recently described by Dr. J. N. Couch of the University of North Carolina, reports *Science Service.* While insect-eating plants such as the Venus fly trap and the pitcher plant are quite well known, animal-catching fungi are rare.

This fungus grows in a thread-like form. Loops are spaced at intervals along the thread. These are the traps. When a worm

sticks its head or tail into one of these loops it contracts, tightening up on the worm and holding it fast. At times a worm may be caught by two of the loops.

When the worm is firmly held, small threads grow out from the main thread. They penetrate the body of the worm and digest it. Dr. Couch was able to watch the capture and digestion of the prey.

Lightning Struck Eleven Times

THE Empire State Building, New York City, has been struck often by lightning. In the accompanying photograph, an ordinary camera seems to reveal one brilliant

With a high-speed camera

flash. Actually, when this shot was made, the building was struck 11 times in 0.36 of a second, it was shown by General Electric's special high-speed camera. To the right is a series of blurs, indicating the first of the 11 flashes. The flash second from the left is shown, upon close examination of the photographic negative, as a double stroke, as is the fourth from the right.

Bees Benefit the Other Fellow

THE beekeeper is not able to collect the cash value of the work his bees do—except for the honey they produce—Dr. C. A. Browne, of the United States Department of Agriculture, said recently at a meeting of beekeepers. This by-product labor of the bees, three to ten times the value of the honey and beeswax, is the pollination of growing crops—particularly fruits.

In Germany during the war, said Doctor Browne, bees were much neglected, and a serious drop in fruit crops resulted because of poor pollination. Many other insects are pollen carriers, but early spring when most of the fruit trees are in bloom is too early in the season for most insects other than bees.

Doctor Browne emphasized the need to develop industrial uses for honey to maintain a market so that beekeeping will continue profitable enough to support the by-product work of the bees. Honeys vary considerably in chemical composition and more chemical research is needed to determine the suitability of each type for specific industrial uses.

CAMERA ANGLES

Conducted by JACOB DESCHIN

High Film Speeds and the New Season

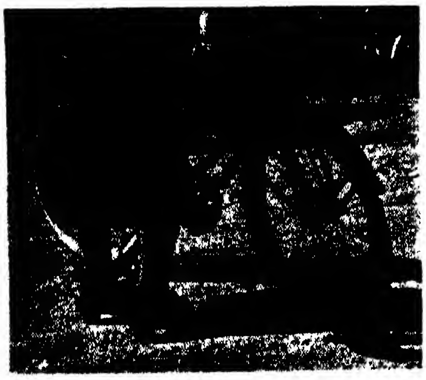
WHILE the enthusiastic amateur never permits his camera to gather dust on the shelves during any season and has kept it busy all through the winter months, nevertheless all of us do welcome the advent of spring for the innumerable opportunities for picture-making that these months afford.

"Preparations"

"Up a Tree"

This year we have a rather odd situation in the fact that on the eve of those seasons of the year that are most gloriously suited to general outdoor picture-making because of the longer and brighter days, the chief film manufacturers should be putting out or are on the verge of introducing the fastest speed emulsions ever made available to the general public. And it is particularly significant and thrilling to know that these emulsions, although rated very highly as to speed, have not suffered in the matter of grain and in addition have the advantage of a surprising latitude, permitting over- and under-exposure to an unusual degree.

While fast film and the sunny months may seem a peculiar combination, on second thought it must be seen that although high-speed emulsions are ordinarily associated with outdoor night and indoor shots, at home, in the theater, and so on, there are many situations in the generally sunny outdoors when a fast film is very useful and will do work not easily performed by film of the "regular" speeds. Shadows abound in which detail is wanted; a fast film is needed to "cut" into them and record them properly. The use of fast film also permits employment of the deeper filters without the loss of the advantage of snapshot exposures. Action shots during certain parts of the day or in locations where the sun does not reach directly are facilitated by fast film; even in brightly lighted places, a little closing down of the lens for better insurance of depth is possible without the sacrifice of high shutter speeds. Besides, even during the sunny months, there are times when the sky is clouded over and fast film becomes as welcome as it is during any season of the year under similar circumstances.



"Waiting for the Start"

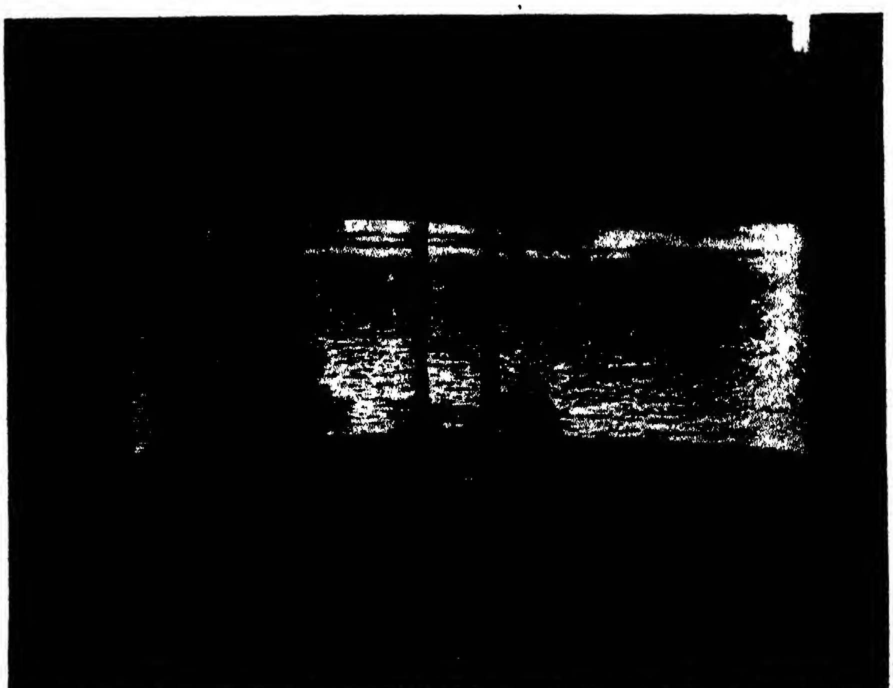
The four pictures accompanying this article illustrate some of the reasons why fast film is helpful any time of the year and not the least in the spring. Not all have been completely successful in the matter of describing the shadow detail and some recorded detail has been lost in the magazine reproduction, but the reader will understand from these the sort of thing we have in mind.

For example, the shadow cast by the squirrel's head must not be so deep as to obliterate the detail on the shadow side of the head and the man's face and hands in "Preparations" should be sufficiently impressed on the film to show up on a print.

Insofar as film speed generally is concerned, if the film is really high speed, as these new films are, and their fine grain characteristics have not been harmed but, in some instances, have even been improved, may we not say that now we have finally achieved the universal film that will do for all occasions, whether shots in the theater at night or snapshots in the park by the light of the open sky?

Developing Filmpacks

NOW and then someone reports the unfortunate experience, when developing filmpack films, that the paper adhering to the ends of the individual films somehow covered a film or two during development, preventing the action of the developer on part or parts of negatives sufficiently long to leave a definite mark. To avoid this in future, we suggest that you try the following precaution. Taking two or three films at a time, snip off the paper edge under the trimming board knife. You must take care, of course, that you cut only the narrow edge where the paper adheres. This operation completed, your films will be clear of all



"A Sure Sign"

paper even before immersion in the developer bath and you will be able to proceed with the developing as secure with regard to the paper hazard as if you were using cut film.

Photography Aids Science

THE popularity of the camera in the purely amateur sense has more or less held the spotlight in this, the Golden Age of Photography. However, the camera has been of such solid and fruitful usefulness in the fields of teaching and research that it recently inspired Dr. Edwin B. Mains, director of the University of Michigan Herbarium, to declare that new cameras and films, together with simplified photographic processes, are facilitating teaching and research methods in the natural sciences.

The new developments of the photographic field, Dr. Mains said in discussing the photographic exhibit of the 1938 Michigan Academy of Science, Arts and Letters in Ann Arbor, are opening up wide fields other than that of recreation for the candid camera fan. They have already provided a means of studying minute botanical detail in accurate color, he said. Another hopeful development seen by Dr. Mains was the fact that the new photographic processes are fast coming within the financial means and abilities of high school teachers and pupils who have not had the facilities that were heretofore necessary for work with the camera and in the darkroom.

Theme Competition

HERE is a third opportunity for the readers of this department to win prizes by competing in a fascinating phase of the art of photography. A definite assignment is given in interpretive photography, to be fulfilled according to each individual photographer's own imagination or artistic ability. Prints submitted in these monthly competitions will be judged on the interpretation of a theme, as well as on pictorial appeal and technical excellence. Each month two cash prizes—$10 for the first prize and $5 for second prize—will be awarded, and there will be two honorable mentions, each to be a year's new or extension subscription to Scientific American.

The simple rules of the contest are as follows: (1) All prints submitted must be mounted, the over-all size *of the mounting* not to exceed 11 by 14 inches. Prints may be any size from 3¼ by 4¼ inches up to the maximum area of the mount. (2) Not more than one print may be submitted by each contestant, it being left up to him to judge his own work, and to select the one which, in his opinion, best portrays the theme of the assignment. (3) Prints may be forwarded by any means desired but each must be accompanied by the required return postage. (4) No names or titles are to be placed on the face of the photograph; on the back of the mounting must be given the contestant's name and address, together with the name of the camera and of the film employed. (5) The competition will be judged by the conductor of this column and the editorial staff of Scientific American. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants. Prize-winning photo-

graphs will become the property of Scientific American to be used in any manner at the discretion of the publisher. (6) No entries will be considered from professional photographers. (7) Prints may be black-and-white or toned; no color prints will be considered. (8) All entries in the third Scientific American Theme Competition (June, 1938) must be in the hands of the judges by July 1, 1938. The results will be announced in our issue dated September 1938. (9) This competition is open to all amateur photographers who are not in the employ of Scientific American.

JUNE COMPETITION THEME: "WORK"

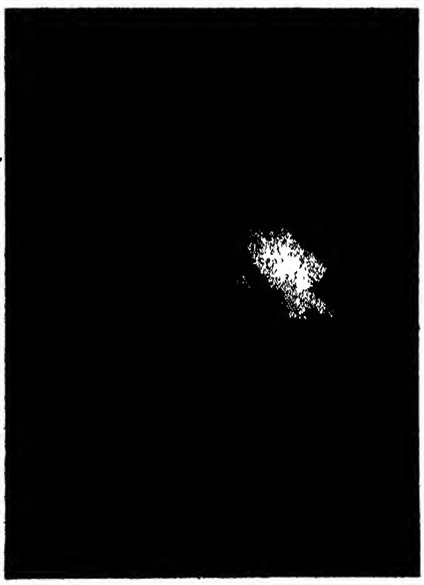
The assignment for the third competition is "Work." In this case, the interpretation of the theme might involve an odd shot of a steam shovel gnawing away at a rocky bank, a laborer taken from some unusual angle, a house-wife in action, and so on to the limit of your resourcefulness. These hints are thrown out at random and are not necessarily to be considered as definite suggestions.

Address all entries: "Work" Competition, Photograph Editor, Scientific American, 24 West 40th Street, New York, N. Y.

Here is something well worth shooting at, both to test your sense of photographic interpretation in competition with others, and because of the prizes involved. Go to it!

Moon Phenomenon

THE "cross" effect sometimes obtained when photographing the sun was recently caught by this department when trying to photograph a moonlight scene. The



"Moon Rays"

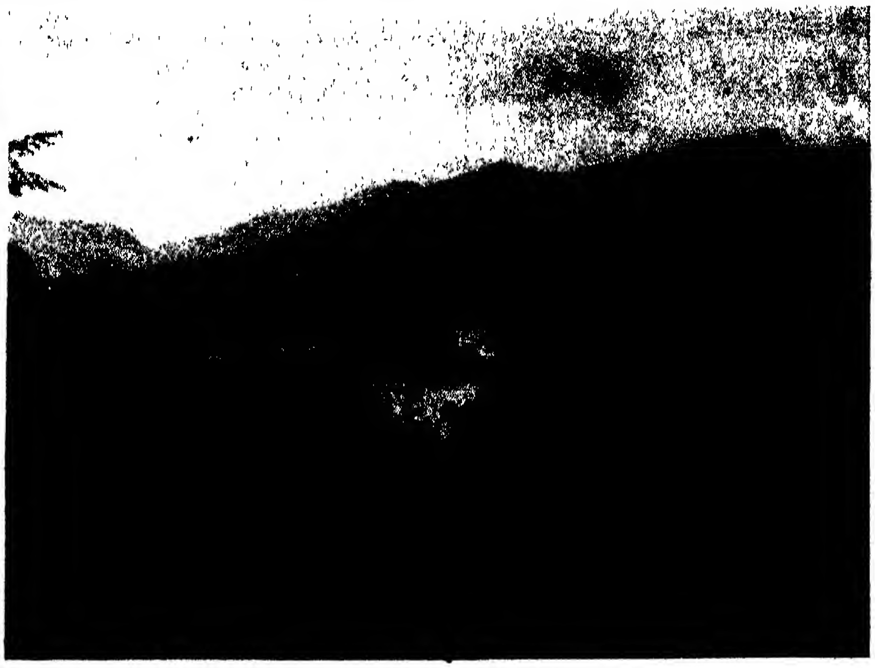
lines shooting out from the moon are fairly distinct, although we would have preferred considerably less movement in the clouds. The exposure was about 45 seconds.

Cleaning Trays

AFTER each processing session, it is a good practice to clean the trays thoroughly so that the next time you can get to work without having to clean the trays before starting. Most of us are content merely to run some water into the trays, swish the water around a bit and let it go at that. However, you can purchase at the five-and-ten-cent store a simple household

When you write to advertisers

● The Editor will appreciate it if you will mention that you saw **SCIENTIFIC AMERICAN** it in



A platinum print of 1901

device a stick attached to a miniature mop—that will help you to do the job better. With this you can wash and clean the trays at the same time, work into the corners and along the sides of the trays so that all dirt is mopped away, and generally make the cleaning chore both simple and effective. If you make a regular practice of thus cleaning up every time you use your trays, you will not only be able to begin the next session with clean equipment, but you will also find that the cleaning job is easier to do while the sediment is still moist from the working solutions.

They Were Good Then, Too

NO, we don't know it all. Back in 1901 they were making platinum prints and doing a beautiful job. Witness the example here illustrated, the work of Ernest C. Sherburne, of Boston, now editor of *The Christian Science Monitor's Weekly Magazine Section*, who made the print in 1901 when he was the paper's staff photographer. Today, he is an enthusiastic minicamera fan, having qualified for this title by reason of his devotion to the candid-type of camera, which he employs on every possible occasion.

He thinks the platinum process very simple.

"Print by reflected light," he says in describing the process, "inspect at will for depth, wash in a ferro bath to develop the image, five minutes in hydrochloric, wash five minutes, and that's all, there being no hypo."

Platinum printing is today a lost art and those who would try it will find that they must coat their own paper.

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

Photrix Meter

THE Photrix electric exposure meter, which can be worn fastened to the wrist, like a watch, leaving both hands free to operate the camera, is said to work on the same principle as any other photoelectric exposure meter, with the difference that the Photrix does away with setting levers or dials. Of course, the Photrix ($16.00) may also be held in the hand like any other electric exposure meter. The Photrix has no computer dial, the function of this dial being performed by an arrangement of the scales.

Briefly, the distributors say, the secret is this: For a number of popular film speeds and F: stops—for instance 23 SCH (24W), F:11 or 20 SCH (12W), F:8, and so on—the exposure time can be read directly at a glance. For other F: stops, all one has to do is to go stepwise to the right or to the left on the scales of stops and exposure time. For use with moving picture cameras, a "frames-per-second" scale is inserted in the exposure time scale.

The scale of the Photrix is 1¾ inches long with clear, equally spaced figures over the full extent of the reading range. The face of the Photrix measures 2 by 2½ inches, the thickness of the meter being only 13/16 inches. It is shown in the illustration compared with a folder of matches. The Photrix externally is smooth Bakelite and glass without any protruding parts.

Quinotol Developer

QUINOTOL, a developing agent of great versatility, hitherto obtainable only as a foreign product at relatively high prices,

has now been introduced to the American market as an American product. While Quinotol (Chlor-H-Quinone) has not been generally familiar to amateurs, it is not new to the experienced photographer. The uses of Quinotol (oz. 50¢; ¼ lb. $1.75; 1 lb. $3.00; 5 lbs. $5.50) are multiple and when made up according to the Formula LR23, which is now announced by the distributors, may be employed in developing chloride, chloro-bromide, and bromide papers as well as negatives in both tray and tank.

16-MM ENLARGER

A NEW type of enlarger for making black-and-white negatives from single frames of 16-mm motion pictures is the Kodak 16-mm Enlarger ($15.00). Negatives may be made in a few seconds from either black-and-white film or Kodachrome, and from these enlarged negatives, both contact prints and greater enlargements are possible.

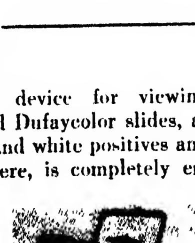
The enlarger is of particular value to the amateur movie enthusiast who possesses no darkroom or other facilities for making enlarged "stills" from his 16-mm reels. It permits making a series of negatives in rapid succession, and eliminates the need of immediate processing.

The enlarger is constructed, for compactness, in the form of a folding Kodak and is loaded and operated in much the same way. A film gate, mounted in front of the enlarger lens, has a mask opening the exact size of the 16-mm frame. The film is positioned over this opening, between guide pins. A locating pin engages one perforation, keeping the film in exact alignment. There is no cutting of the movie film. After positioning, the cover of the gate is closed, and a brief exposure made by incandescent light.

With a film frame of average density, a five-second exposure is correct with "SS" Pan film, when the film gate is held 5 inches from a No. 1 Photoflood lamp. The enlarger loads with 616 film.

MAGNO VIEWER

A NEW type of device for viewing Kodachrome and Dufaycolor slides, as well as 35-mm black and white positives and negatives, pictured here, is completely enclosed in a small metal box, which is set up or closed, as desired, quickly and without bother. The compactness of the unit makes it completely portable. The Magno Viewer ($17.50) is equipped with a condenser lens that provides a two-times linear magnification of the 35-mm positive; that is, a picture about two by three inches. The "observation" window effectively shields the lens and thus assures a comfortable view of the magnified picture, the illumination, by transmitted light, being provided by a specially designed lamp of the Osram type.

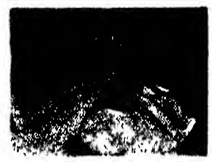


In connection with the Magno Viewer, announcement is made of a new type of 35-mm transparency frame ($5.50 for 25)

made of a special composition material. Instead of having to be bound with tape in the usual transparency frame manner, the positive or transparency is simply placed between two thin pieces of glass, inserted in the frame and snapped into position where it remains firmly in place.

Mushroom Flood Bulb

THE Schickerling Mushroom Bulb Photo Flood ($1.00), so named because its main body is shaped like a mushroom, is announced as the first significant improvement in photographic lighting since the introduction of flood lamps. The invention of Conrad Schickerling (known throughout the radio industry for his advancements in radio vacuum tubes), the Mushroom Bulb has an average life of 10 hours of peak performance, plus 10 to 15 hours more of adequate working illumination, giving improved color balance throughout.



The unique construction features of the Mushroom Bulb include the concentrated cool coil filament, large heat dissipation area, much higher actinic value, silver nitrate and argon filler, and an ultra high vacuum. It has an inside reflector and an outside frosted diffuser. Due to the unusual filament design, the Mushroom Bulb is said to project a whiter light with an improved red actinic ratio.

The Schickerling Mushroom Bulb may be used in all phases of photography where artificial light is needed—in the home, for studio work, copy work, commercial photography, in laboratories, and for still and motion pictures. Moreover, it is claimed, it has a longer life than the average Photoflood, thus becoming more economical. This bulb operates on either A.C. or D.C.

V. P. Camera

MADE in England, the V. P. Twin camera (99 cents), taking 16 pictures on any standard vest pocket film, has just been introduced here. Among its features is a ground, polished, and centered meniscus lens which permits sharp portraits and snapshots from a few feet to infinity. The V. P. may easily be loaded in daylight. The shutter is fixed on the front of the camera, giving instantaneous exposures without vibration. The film numbers are seen through a double window in the back of the camera. The view finder is instantly snapped into position for either horizontal or vertical pictures.

Superpan Supreme

AGFA Superpan Supreme, the fast panchromatic film recently introduced to the motion-picture industry, has been made available in cartridges, spools, and darkroom loading packages. Although a new product, exceptional recognition has already been given to this film, for Supreme, together with the Agfa Ultra-Speed Pan, is the first film in seven years to win the Class I award for technical achievement of the Academy of Motion Picture Arts and Sciences.

As supplied for 35-mm still cameras, the

new film will replace the Fine Grain Superpan formerly supplied and which it doubles in speed, though it cuts down the grain size of the former film. Greater brilliance, anti-halo protection, and a surface coating for minimizing abrasion marks are other features of the new film.

Until new cartons can be provided, Superpan cartons bearing the label "New Type" or "Supreme" are being used and can be identified as containing the new Superpan Supreme.

Arc Lens Shade

SCIENTIFICALLY designed for working with or against the light, the Arc Lens Shade ($1.00 to $2.00, depending on size) has a unique, tapered shape, eliminating cut corners. It is easily and firmly attached to all standard lens mounts. Distributors claim it will help to produce clearer, crisper pictures, entirely free from lens flare.

Electric Agitator

THE Imperial Electric Agitator is designed for the purpose of shortening negative developing time. The agitator ($16.50) makes possible quick, positive, and even agitation, scientifically controlling the grain and resulting in precise, clear negatives. The Imperial Agitator uses a minimum amount of electricity and is made to accommodate all miniature developing tanks.

Bakelite Developing Trays

TWO economical developing trays, constructed entirely of Bakelite molded and designed to develop large-sized prints, have recently been introduced. Solid and heavily constructed to withstand considerable abuse, the trays have no reaction on the developer and hypo baths, and, being chemical resistant, they are unaffected by the corrosive action of those chemicals.

Center-Numbering on Roll Film

CERTAIN cameras now on the American market take twelve 2¼ by 2¼ inch exposures on B2 or PB20 roll film; to accommodate cameras of this size where "window-watching" is required, the manufacturers of Superpan, Super Plenachrome, and Finopan have provided these films with center-numbering. This center numbering is printed on the protective paper of the roll-film so that as the film is wound through the camera, the numbering will readily indicate the proper spacing of the 12 exposures.

Imperial Magniviewer

THE Imperial Magniviewer is a flexible optical lens mounted on a universal joint on the enlarger easel or retouching table. The Magniviewer ($5.50) provides better definition and greater accuracy, giving sharp, highly magnified images in true proportion. It may be quickly and easily fitted to the baseboard of any enlarger.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

***Q.* I would like a filter but do not know what color to get—red, yellow, or green. I want it to use when taking clouds and snow pictures, chiefly. Which color would be the most satisfactory?—D. S.**

A. For all-around purposes it is generally agreed that the medium yellow filter is the most useful; if only one filter is wanted, this is the one to get, for it will do practically everything the average photographic work requires—record clouds against a blue sky, control the light in snow photography, cut down the harshness of sunlit water, and so on. One of its chief virtues is that it requires only double the normal exposure when using panchromatic film; even this may be avoided simply by opening the lens wider by one stop. In most cases the narrowing of the depth of field caused by the larger opening will be of no consequence since outdoor work usually calls for relatively small stops.

***Q.* I would like to obtain a schedule of the U. S. Scheiner ratings for the following films (films are listed in reply).—J. J. M., Jr.**

A. As you probably know, films are rated differently in daylight and tungsten light. We shall, therefore, give both ratings as reported in the most recently revised edition of the booklet, "Practical Speeds of Films and Plates."

	Daylight	Tungsten
Eastman Standard (Kodak Regular)	17	13
Kodak Verichrome	20	16
Kodak Supersensitive Panchromatic	23	20
Kodak Panatomic	19	16
Agfa Standard	18	14
Agfa Plenachrome	20	17
Agfa Superpan (roll and pack)	25	24
Agfa Finopan	21	19

***Q.* I have a camera using 35-mm film. I have had a little difficulty with grain in enlarging, even though I have used .... developer in a film tank and have followed instructions as to time and temperature. Would there be any advantage in using this same developer for only ¼ or ⅛ the normal development time and then using a one-solution intensifier of the .... type to bring my films up to the required density? Would this solve the grain problem for me?—E. B.**

A. The developer you mention, while generally satisfactory for larger negatives, is today held not to be suited for fine-grain development. Many fine-grain developers are available, in liquid form ready for use, that will do a fine-grain job for you in fine style if you will take just ordinary precautions as to temperature and time of development. Among the favorites may be mentioned M.P.G., G.D.X., Infinol, Champlin 15, and others. While we have not tried the experiment you suggest, we doubt whether underdevelopment to the extent you mention, followed by intensification, would be as effective, or even as easy, as simple, straightforward development in a regular fine-grain developer. Besides, the intensifier you cite has a tendency to introduce grain on its own account if immersion is prolonged beyond a certain minimum.

***Q.* I would like to take instant post-card size pictures that can be sold to the posers on the street. The picture is to be a direct photo without the use of negative and is to be finished inside the camera in about one minute. I can purchase such a camera from a storekeeper who cannot tell me how to use it. I would appreciate information.—A. B.**

A. The camera you have in mind is described and discussed on pp. 23 and 24 of George H. Chappell's little handbook, "The Itinerant Photographer," and full instructions for operating it may be had by writing to The Daydark Specialty Company, Benton and Baldwin Streets, St. Louis, Mo. The apparatus is called the "Black and White Camera."

***Q.* As a graduation present I asked my parents for a new camera. The choice was left to me. I wrote to the various companies asking for their catalogues but I was thoroughly lost. Will you please explain to me what the names given to the different shutters and lenses mean? What is the significance of the different focal lengths (F:3.5, F:4.5, F:6.3, and so on)? Do you think I would be capable of operating a miniature camera?—D. W.**

A. Though lacking the advantage of your personal acquaintance, we presume you

possess the blessings of sight and the use of your hands; for these reasons, nothing stands in the way of your attaining proficiency in the operation of a miniature camera. It is simply a matter of learning what all the gadgets do and what part you play in their doing it. However, from your questions, we gather that the first thing you ought to do is purchase or consult some elementary book on photography. You can learn to operate a miniature camera in an hour or less but that won't do you any good unless you know something about photography. For example, take your question concerning focal lengths, which you follow with a string of lens speeds, the implication being that you have confused the latter with the former. Since it is impossible adequately to treat your questions in the short space allowed to replies in this department, the best we can do is to say that, broadly speaking and leaving aside all technicalities, the focal length of a lens determines the amount of subject-matter appearing on the negative—the longer the focal length of the lens, the smaller the amount of subject-matter appearing on the negative. Thus, a so-called "wide angle" or "short focus" lens might include the whole side of a room, but from the same vantage point, a long or "telephoto" lens might include only the head and shoulders of a lady sitting in a corner of the room, while a "normal" lens, the one ordinarily supplied with a camera, would take in the entire lady, together with the chair she is sitting on, as well as the fireplace. The F: numbers you list refer to the diameter of the lens as it relates to the focal length of the lens; thus F:3.5 means that the lens has a diameter 1/3.5ths of the focal length. Shutters are principally of two types, the focal plane, so called because the shutter operates directly in front of or on a plane with the film, and the Compur type, which operates between or behind the lens.

Q. Is it absolutely necessary to have the darkroom completely dark when printing or enlarging? I must work in a closet which admits a little light through cracks around the door and I have been wondering if this is really harmful?—J. L.

A. Of course, the ideal is a light-tight room, but you will find that the small amount of light thus coming into the work room will not reach the paper provided you are careful to shield the paper by working with your back to the door and using your body as a shield.

Q. I seem to get good results with my visual exposure meter for what is known as "normal subjects" but where the foreground is involved or holds special detail which puts the subject out of the normal class, I find that I cannot use the values which I read.—N. S. D.

A. By "normal subject" we presume you refer to a subject in which the range of tone is sufficiently long to permit the meter to "average" the tones (reflections) from, say, the position of the camera, and obtain a generally correct exposure for the scene. However, where it is desired to record a "heavy" foreground or small detail, it is important that the meter be brought closer to the object so that, as much as possible, nothing is included within the angle of the meter other than the specific object or small area in question. In this way, the only light read is that coming from the segregated subject. The reading you obtain in this way, provided you do not permit the shadow either of the meter or yourself to fall upon the object, will be the correct one for the particular subject, regardless of the position of the camera.

Q. My camera uses 35-mm film and has a lens of F:4.5 speed. What would the speed of this lens be, relatively, when using the new film made by Agfa (Ultra Speed Panchromatic)? What are the possibilities of my camera using this film? Are indoor snapshots at night possible without the use of additional light other than ordinary reading light?—T. R. B.

A. Roughly estimated, the speed of your lens under the circumstances would be increased to somewhere between F:2 and F:2.5. The great opportunities thus opened up for users of cameras with lenses of F:4.5 are obvious and should go a long way toward encouraging those persons who cannot afford the higher priced lenses. Actually, what it means is that an F:4.5 lens aided by this film is the equivalent of the expensive fast lenses. Of course, there are other factors, such as the general quality and design of the lens, but the reference made here is entirely to the speed at which an impression is made on a film within a given interval. With this film, indoor snapshots at night by ordinary lighting are "pie" and, generally, this film makes possible many pictures that could not previously be made at snapshot speeds. See also the discussion of the ultra-fast films which appears in "Camera Angles" in this issue. Suggestions for use will be found there.

Q. Can you suggest a method for quickly drying the grooved Bakelite reel in which film strips are inserted for tank processing, when it is desired to develop one film roll after another?—G. B. A.

A. After the film roll has been washed in the tank and the negative strip hung up to dry, take the reel apart, immerse the two sections in very hot water, wipe the reel as well as you can with a towel and expose to the heat of a radiator or hot breeze fan. The speed of drying will surprise you.

Q. In washing a strip of negatives, I use ordinary cold water from the tap. Whatever the temperature happens to be, that is the temperature of the wash water at that particular time. I use an acid hypo fixing bath. Do you think this method of washing is harmful?—J. A. D.

A. By all the gods of fine-grain development, you are beyond redemption. Of course, if your negatives are large enough, say 2¼ x 2¼ inches, so that you do not have to worry too much about fine grain, the fine-grain stricture that developer, fixer, and wash water should all be of approximately the same temperature may leave your results unscathed. However, a very cold washing, the temperature of which is considerably below that of the fixer, will cover your negative with a filmy, splotchy coating which must be removed before the negative strip is hung up to dry. But this is automatically taken care of if you swab both sides of the strip with a viscose sponge.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

LAST month's discussions in this department were rather on the light side, hence this month we offer three items, two of which will rate as advanced amateur telescoptics. All three are by Kirkham. In the first, he gives specifications for a Cassegrainian telescope with a spherical secondary instead of the usual hyperboloidal secondary, in the second he gives data for designing special eyepieces for the RFT 'scope, and in the third something easier. Comments from Kirkham's letters suitably introduce the first item: "The formulas for computing how much correction to put on the primary mirror to make it fit a spherical secondary mirror instead of a hyperboloidal secondary are not very terrible. The spherical aberration of the secondary is computed first and then a primary is designed to produce that much. There is amazingly little difference between the mirror which is necessary and a paraboloid; it amounts to from 70 to 90 percent correction, depending on the design of the 'scope. There should not be any observable difference in the performance when the telescope is used visually, and the job of deforming the tiny secondary mirror, which Porter frowns on so much (ATM, p. 63), is entirely done away with. The formulas are not lying around anywhere that I know of, hence I hereby present them, all worked out and ready to apply. They are based on developments in series by the binomial theorem, and the processes of deriving them would not be intelligible to any but a mathematician, and would not be even very interesting to another mathematician. These developments are on hand, and can be supplied to any who care for that kind of thing."

THE CASSEGRAINIAN TELESCOPE WITH SPHERICAL SECONDARY MIRROR: "The customary curves for Cassegrainian telescopes are the paraboloidal primary and hyperboloidal secondary. As far as I know nobody has ever raised the question of why these curves are used instead of others which might be easier to produce, or even better. Probably the first Cassegrainian telescope was a revamped Newtonian, and the secondary was just naturally made to fit.

"Schwartzschild proposed the aplanatic curves in 1905 and these amount to overcorrecting both mirrors. Apart from increasing the difficulties of construction, these curves are a waste of time and effort, as far as visual instruments are concerned. As a matter of fact, there is no very good reason for not going the other way and removing some of the correction from both mirrors. In changing the figure of the secondary to a sphere, only a fraction of the correction must be removed from the primary mirror. In the usual method of testing a Cassegrainian telescope with a flat, when the secondary is yet uncorrected the entire telescope appears overcorrected. Instead of overcorrecting the telescope as a whole by correcting the primary right up to the full parabolic form, and then going backward by changing the secondary to a hyperboloid, why not stop the correction of the primary at just the right point so that no correction at all will be necessary on the secondary? It can be easily finished up spherical by means of the King test, or by polishing the tool enough to show fringes in monochromatic light, and it will generally be impossible to tell any difference in visual observation between a telescope with these curves and any other curves.

"In Figure 1, if we place a light source at F', the focus of a Cassegrainian telescope having a spherical secondary mirror, a marginal ray will diverge and fall upon the rim of the secondary at H', from whence it is reflected to the rim of the primary mirror at H, and making an angle u' with the axis. If the ray is traced backward along the dotted line, it will cut the axis at a distance b from the apex of the secondary mirror. The longitudinal spherical aberration is $b-p$. We shall designate this spherical aberration by a, and it can quite easily be shown that

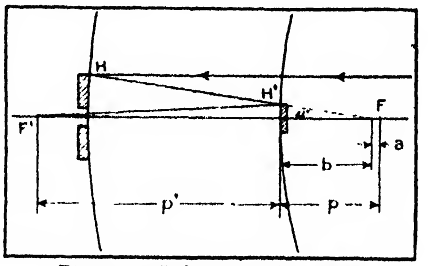


Figure 1: **Sph. Secondary Cass**

$$a = -\left(\frac{R'-p'}{R'-2p'}\right)^2 \frac{r'^2}{R'} \qquad (1)$$

where R' is the radius of curvature of the secondary mirror, r' the radius of its marginal zone, and p' the distance of focus F' from the apex of the secondary mirror.

"Now, obviously, if the primary mirror has this same amount of aberration, then the telescope will be corrected as a whole. If we designate the radius of curvature of the primary mirror by R, the radius of its marginal zone by r, and compute a from the above formula, we may write

$c = -4Ra/r^2 = undercorrection$ (2)

and the percentage of correction necessary for the primary mirror is

$100\,(1-e) = percentage\ correction$ (3)

The quantities a and e are computed only for the marginal zone, and the percentage found for (3) holds for all zones of the mirror.

"If we designate the radius of any zone of the primary mirror by y, then a parabolic mirror tested at center of curvature has the knife-edge or grating movement (assuming the pinhole remains fixed)

$$A = y^2/R \qquad (4)$$

as every amateur knows. If we want to make a Cassegrainian telescope with a spherical secondary mirror, then the knife-edge or grating motion is simply the percentage of y^2/R given by formula (3), or to state it all together

$$A_0 = (1-e)y^2/R \qquad (5)$$

and one has only to apply this correction to the primary mirror, with the assurance that the secondary mirror will fit if left spherical.

"*A WORD OF CAUTION TO NON-MATHEMATICAL READERS:* These formulas are derived according to the conventions of analytical geometry, which is coming more and more into practice, and it is necessary to bear in mind that, after making a drawing of the telescope such as Figure 1, R and R' are *positive* if their center of curvature lies to the right of their surface, and negative if to the left. Likewise, p or p' will be positive or negative according as they lie to the right or left, respectively, of the surface. As an example, p' in the figure is negative.

"I have felt for a long time that amateurs have been overlooking a good bet with these 'elliptical Cassegrainians', as the chief difficulty in producing a compound telescope has always been the satisfactory figuring of the secondary mirror. As a matter of fact, this is about the only real difficulty given by Porter on page 62 of ATM as a basis of his 'and why not to'. I might add, however, that the idea was suggested to a Tacoma amateur some time after this theory was worked out by a member of the Lick observatory, and upon investigation, I understand further that Dr. J. A. Anderson suggested it two or three years ago, and expressed the thought that he would like to see it tried.

"There is another interesting possibility. The primary mirror formed by this formula will not be exactly an ellipsoid, but Schwartzschild has shown that mirrors of reasonable sizes conforming to these kinds of formulas differ from ellipsoids only by very small fractions of a wavelength. The direct focal test could therefore be applied, and a complete Cassegrainian telescope produced with no necessity for zonal measurements whatever, making the job on the whole much easier than the ordinary Newtonian job."

THE idea of a Cass of this unusual type turns out, on investigation, to be older than is mentioned above; evidently it is quite aged, in fact. Kirkham, however, hit on it independently. This happens again and again. With thousands of new and enthusiastic recruits to telescoptics, it is not even remarkable that many a man has a bright idea that someone had in his grandfather's day. Your scribe recalled that Dall, of England, proposed a similar idea in the *Journal of the British Astronomical Association* in 1932—a monthly which, by the way, often contains most interesting discussions of telescoptical subjects—and that he had also discussed it in private letters in the same year. But he never published the details. However, as an amenity, since Dall was known to have made three such Cassegrainians of this type, Kirkham's paper was shown to Dall before publication, and Dall at once voluntarily surrendered any special claim to ownership. Kirkham, when then shown Dall's early correspondence, asked that mention be made that the method

suggested in his final paragraph is the same as the one Dall had described in that correspondence with your scribe. This kind of mutual courtesy is a pleasing relief, considering that many a telescoptician, on learning that another had been trespassing on one of his pet preserves without by-your-leave, has growled and given the other fellow the dog-eye. Verily, your telescolumnist knows, because he has so often stood at the focal point of numerous tilts of this kind, this being the exact point at which the brickbats cross.

SECOND item by Kirkham is also introduced by informal comments from his letter of transmittal: "Let me join with others in the opinion that one of the best things that has yet hit amateur telescope making is the RFT and, in connection with this, altogether apart from the spherical Cass problem, equation 2 of the above Cass paper can be used for deriving the proper amount of overcorrection for an RFT mirror to compensate for spherical aberration of the eyepiece, which is very considerable at $f/3$ or $f/4$. A Huygenian ocular has an unpermissible amount of aberration when you get above $f/10$. A Ramsden begins to gum up the image at about $f/5$, and therefore an RFT cannot possibly work its best unless something is done about the spherical aberration of the eyepiece. It amounts in some cases to 50 percent or more overcorrection."

EYEPIECES FOR THE RFT: "In the past, it has seldom been necessary to apply eyepieces to objectives of greater aperture ratio than about $f/8$. A Huygenian eyepiece of 1" focal length has about .02" longitudinal spherical aberration at $f/8$—quite enough to interfere with the performance of a first class, fully corrected mirror. Most of us have avoided this difficulty simply by asserting that Huygenian eyepieces are no good with reflecting telescopes, and using Ramsden eyepieces. A characteristic Ramsden eyepiece has been found to have about .006" aberration at $f/8$, which in practice is altogether negligible.

"The commonly accepted aperture ratio for RFT seems to be $f/4$ (for reflectors), and it now becomes necessary to see what happens to the eyepiece aberrations when called upon to handle such wide cones of rays. While eyepieces can be designed to have no spherical aberration at all, it is never practical to do so. The whole beauty of the RFT plan is in obtaining a wide field as full of stars as possible. Eyepieces have other aberrations much greater than spherical aberration, which have to be kept within limits. An ocular has quite a job to perform if it gives a moderately wide field of view free from excessive astigmatism, distortion, and curvature, and it is generally impossible to make the eyepiece free from spherical aberration and at the same time keep these other errors within workable limits. The things one would have to do to an ocular to free it from spherical aberration and some kinds of color errors are directly opposed to what is needed to keep the astigmatic and other color errors within the desired limits. When the objective is of very short focus, it becomes absolutely necessary for it to be overcorrected an amount corresponding to the eyepiece longitudinal aberration if most satisfactory results are to be obtained.

"It can be shown by a somewhat lengthy

calculation that an ordinary Ramsden eyepiece of 1.14" focus, when used with a fully corrected parabolic mirror of $f/4$ focal ratio, has almost exactly the maximum permissible amount of spherical aberration, so that a star right in the center of the field will not appear to be larger than if the error were absent. We must not jump to the conclusion, however, that the state of affairs is therefore satisfactory. There are six other major errors which, when taken all together, will run the total error of the system way over the limit, especially in the edges of the field. It is easy to see that, if the one error uses up every bit of available 'tolerance' for a star most favorably situated, there is no hope at all for stars to look like more than dirty spots at a distance of 15° to 20° from the center. On the other hand, it is quite simple to overcorrect the primary mirror sufficiently to bring this large central error to zero, so that we have all the tolerances left to take care of the other aberrations about some of which absolutely nothing can be done.

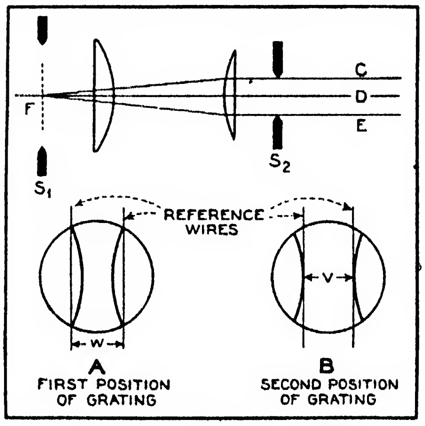


Figure 2: **RFT eyepiece data**

"In most cases, this method gives a rather close approximation to an 'aplanatic telescope'. Since coma is the principal part of the aberrations of a reflector after spherical aberration is eliminated, the plan increases the general usefulness of the system as a whole far beyond what could be hoped for if it were possible or practical to obtain eyepieces free from spherical aberration. The faults of the eyepieces indeed turn out to be a blessing in disguise.

"In order to figure a mirror so that it will have a certain predetermined amount of spherical aberration, it is necessary to know how much the knife-edge must move in measuring the different zones. It is not difficult to show that, calling the radius of curvature of the mirror R, the desired amount of aberration a, and the diameter of the mirror d, the amount of overcorrection necessary is

$$e = Ra/d^2$$

If we denote the radius of the zone we wish to measure by y, then the knife-edge shift for this zone is

$$(1 + e)y^2/R$$

instead of the old formula

$$y^2/R$$

which corresponds to a paraboloid. In these formulas, the aberration a is considered positive when the marginal rays come to a focus *closer to the eye* than the axial rays; that is, when the Ronchi bands behave, in testing the eyepiece by the method about to be given, like those of an oblate spheroid.

"In practice, a is the amount of aberration of the eyepiece to a bundle of rays which pass straight through it. If first class eyepieces are purchased from a reliable dealer (at a fair price!) he may in some cases be able to furnish the telescope maker with exact data as to the amount of aberration of his oculars. In case of oculars of known construction it can be found very exactly by ray tracing, using the formulas given in many optical books. For Ramsden eyepieces of about the usual form, having two lenses separated about three-quarters of the focal length of the entire ocular, neither of which is a compound lens, a sufficiently exact working guess is $a = .018f_e$, where f_e is the focal length of the eyepiece, provided that the objective has a focal ratio of $f/4$. If the particular Ramsden eyepiece differs much from the standard ones described in ATM by Hastings and others, the formula will be quite worthless.

"The aberration can be found quite accurately by experimental methods requiring no special equipment not already possessed by the mirror maker. Figure 2 represents a Ramsden eyepiece being tested for a. A stop S_2 is made exactly the size of the exit pupil of the completed 'scope, and placed exactly in the center of the eye-lens as shown. It is then turned toward a distant streetlight, and a Ronchi grating placed at F, with the eye just behind. A round spot of light will be seen, just as in testing a mirror at center of curvature, and it will be crossed by the Ronchi bands in exactly the usual way. It is more than a safe bet that the eyepiece will have positive aberration, and the appearance will be that of an oblate spheroid. It is necessary only to measure the aberration by King's test, viz., by finding alternately where the grating must be placed to make V in B, Figure 2, equal to W in A, Figure 2. The longitudinal shift necessary is equal to a for that particular eyepiece and exit-pupil. If a couple of thin wires are stretched equidistant from the center, across the stop S_2, they will be plainly visible like ruled lines across the spot of light, and will be very convenient reference marks to go by in judging the position of the Ronchi bands. In the first place, adjust the grating to make the bands coincide with the wires in the center (V), and then move the grating longitudinally until they coincide at the edges (W). The shift will be equal to a. The wires should not be more than one-third the diameter of the stop S_2 apart, preferably somewhat less.

"What kind of eyepiece is recommended for RFT use? Nothing will be found to have much advantage, if any, over the Ramsden ocular of about the usual design, but by all means obtain a first class one. The only really outstanding fault of these oculars is the color error. This can be practically eliminated by several methods without changing the general design of the Ramsden ocular very much, since it is so satisfactory in other respects. The writer has found that the substitution of special glasses instead of the original crown glass can be made to reduce the error almost to the vanishing point. The König ocular is another entirely satisfactory revision of the Ramsden. It is sold under many names by different makers, and is often designated as the 'Achromatic Ramsden'. It has a compound eye-lens made of crown and flint glasses of almost the same refractive index but widely different dispersions. It is not

to be confused with the ordinary Kellner ocular, which is not at all satisfactory. All these eyepieces have about the same central spherical aberrations and longitudinal chromatic aberration, however.

"Most first-rate manufacturers make oculars of truly wonderful character, not all of which are satisfactory for use with very short focus objectives."

LAST October this magazine published an outstanding article in which most human beings were divided into extraverts and introverts, the extravert being a practical-minded, direct-acting, go-getter of a fellow who wants results as quickly as possible and is impatient of theorizing that lacks application, while the introvert finds his fun in thinking. Amateur telescope makers can similarly be divided into extravert and introvert types. The extravert mainly wants a telescope and is impatient of any kind of foolishness like stopping to philosophize about the whichness of the why as he proceeds to make one, while the introvert, who is probably in the majority in this hobby, largely regards the whole job as a good excuse for all sorts of brain racking about such intrinsically interesting things as the following, by Kirkham:

"The amount of glass to be removed in paraboloidizing a mirror varies with the cube of the diameter of the mirror, if the focal ratio is the same in both cases. You have to tear out eight times as much glass in figuring a 12" mirror as you do in figuring a 6" mirror, provided that the figuring is done in the center zones of the mirror, and nothing is removed from the edge. Furthermore, the amount of glass removed varies inversely as the cube of the f number. For example, you have to remove 2x2x2 = 8 times as much glass in figuring an $f/4$ mirror, as in figuring an $f/8$ mirror. It's quite interesting to note that you have to scrape off 64 times as much glass to figure a $f/4$, 12" mirror as you do when you figure a 6", $f/8$ mirror.

"When you figure a 6" mirror, of 48" focus, you have to remove .000,108 cubic inch of glass. If all of this was in one chunk, it would make a cube .0477 inch square, or about 1/21", which looks like a lot more than one would imagine. There is another way to figure a mirror; that is, to leave the middle untouched and remove glass from the outer zones. This method involves removing exactly twice as much glass. The size of the representative cube of glass (1/21") varies directly as the diameter of the mirror, and inversely as the f number. Hence, a 6", $f/4$ mirror would have a cube of glass 2/21" thick removed in figuring. A 12", $f/4$ mirror would have a cube 4/21" removed."

With the above, "Kirk" included a formal proof, but this contains too many integration signs and too many formulas to present here; interested readers may, however, borrow it from ye scribe.

In a private letter Kirkham writes: "The *average* amateur will do well to forget about 'super-colossal-ultra-hyper' oculars and get a real, grade A, plain Ramsden. And then, if someone feels he simply must go high hat, let him go after an achromatized Ramsden and, incidentally, prepare to part with some real kale. It takes a real optical designer just to *pick out* a suitable ocular for special purposes like RFT."

STELLAFANE convention, Sat. Aug. 6.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

LIGHT FILTERS, by K. Brandt, is a 48-page pocket-size booklet, thoroughly illustrated with photographs and drawings, telling the whole story of the filter problem in amateur photography. It tells what filters do and how they do it; it tells what filters to use under certain conditions and how to use them. *American Photographic Publishing Company, 428 Newbury Street, Boston, Massachusetts.—50 cents.*

YOUR EYES AND HOW THEY FUNCTION is a pocket-size booklet which gives the elementary facts about eyesight. It discusses the eye and how it works; eye defects and how they are corrected; modern lenses and their advantages. It shows the advantages of the better vision which can be obtained through the proper application of optical science. *Write for Bulletin 638A, Scientific American, 24 West 40th Street, New York City.—3 cents.*

PRINCIPLES AND METHODS OF TREE-RING ANALYSIS, by Waldo S. Glock, is a Carnegie Institution of Washington publication, with 100 pages of text and numerous illustrations, containing a detailed exposition of the noted Douglass method of dating prehistoric archeological discoveries by means of tree-ring sleuthing. It also contains much pertinent data on the interpretation of tree-rings in general for those not immediately interested in archeology.—*Carnegie Institution of Washington, Washington, D. C., $2.00 (paper), $2.50 (cloth).*

THIRTY-MILE EYES IN SIXTY-MILE CARS discusses one of the common causes of automobile accidents—defective eyesight. Statistics show the cost of being careless about your eyesight, as applied to the operation of motor vehicles. This cause is comparatively easy to remedy; the booklet tells how. *Write for Bulletin 638B, Scientific American, 24 West 40th Street, New York City.—3 cents.*

BLASTERS' HANDBOOK is the ninth edition of a 281-page pocket-size volume, well illustrated with drawings, discussing practically every conceivable phase of blasting; for engineers, miners, farmers, and so on. Complete index. *E. I. Du Pont De Nemours & Company, Inc., Advertising Department, Wilmington, Delaware.—$1.00.*

WILLSON PRODUCTS FOR INDUSTRIAL SAFETY is something more than an ordinary catalogue. It describes and illustrates industrial safety devices such as goggles, respirators, fume and smoke masks, welding helmets and shields, and so on. Its 34 pages are a veritable guide to personal safety in many industries. *Write for Bulletin 638C, Scientific American, 24 West 40th Street, New York City.—3 cents.*

SERVICES OF THE NATIONAL BUREAU OF STANDARDS TO THE CONSUMER contains numerous illustrations of equipment and devices used at the Bureau to evaluate commodities commonly purchased by the consuming public. The text includes brief items telling what has been done to improve such varied products as automobiles and dental products, electric lamps and shoes, insulation and tableware, and many other things. Information is also given about the establishment of commercial standards and simplified practice recommendations covering many commodities of consumer interest. *National Bureau of Standards, Washington, D. C.—Gratis.*

INDUSTRIAL CAPACITOR MANUAL deals with ratings, required capacities, power factors, and other engineering and servicing aspects of motor-starting capacitors. Simple self-calculating charts are included for solving the necessary mathematical problems. *Write for Bulletin 638D, Scientific American, 24 West 40th Street, New York City.—3 cents.*

THERMAL SPRINGS IN THE UNITED STATES, Geological Water-Supply Paper 679-B, describes the different hot springs and their geology, with maps. *Superintendent of Documents, Washington, D. C.—35 cents (coin or money order).*

DO YOU KNOW? is a collection of short pithy paragraphs regarding railroad statistics, attractively printed and bound in pocket size. For example: ". . . that the first 'Stop! Look! Listen!' sign was drawn in 1884 . . ." ". . . that the employees of the American railroads earn and spend two billion dollars a year for the needs of their families . . ." ". . . that the speed of freight trains has been stepped up 50 percent in recent years . . ." *Write for Bulletin 638E, Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE LARGEST STREAMLINERS IN THE WORLD is a circular giving the technical details of many of the streamlined trains now in operation. *Pullman-Standard Car Manufacturing Company, 79 East Adams Street, Chicago, Illinois.—Gratis as long as limited supply lasts.*

SHOULD HUSBANDS KEEP HOUSE? is a 32-page illustrated booklet that explains how research and the manufacture of steel has helped to make possible a large amount of attractive labor-saving home equipment. It also tells how to take care of this equipment—kitchen ranges, refrigerators, bathroom equipment, cooking utensils, and so on—in order to get the best service from them. *Write for Bulletin 638F, Scientific American, 24 West 40th Street, New York City.—3 cents.*

PICTORIAL CHARTS AND MAPS is a catalogue of available charts which cover such subjects as geography, population, crime, medicine, and so on. It will be of particular interest to instructors and lecturers. *Pictorial Statistics, Inc., 142 Lexington Avenue, New York City.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Real Teeth

OUT of the mill of the present session of the Seventy-fifth Congress has come a piece of legislation which, because of its importance, warrants much more publicity than it has so far received. The legislation in question is in the form of an amendment to the Federal Trade Commission Act and it represents a radical increase in the power of governmental supervision over business practices.

Heretofore the Federal Trade Commission has had the power to restrain unfair methods of competition in commerce. In construing the power of the Commission the courts have held that the Commission could prohibit only those unfair business practices which were used in competition with other persons engaged in commerce. If no competition existed the Commission could not act even though business practices which were unfair and deceptive to the public were employed.

Under the new Act the Commission is not only empowered to restrain unfair methods of competition but also "unfair or deceptive acts or practices in commerce." Accordingly, it will no longer be necessary for the Commission to prove that the party proceeded against is engaged in competition with other persons.

A significant innovation in the new Act is to be found in the provision that hereafter it shall be an unfair and deceptive act to disseminate any false advertisement by mail or in interstate commerce or under certain other circumstances for the purpose of inducing the purchase of any food, drugs, medical or surgical devices, or cosmetics. The Federal Trade Commission is specifically empowered to restrain the dissemination of such false advertising. Under certain prescribed circumstances the dissemination of such false advertising is a misdemeanor subjecting the violator to a fine of not more than $5000 or to imprisonment for not more than six months, or both.

The Act also makes important changes in the procedure for reviewing and enforcing the orders of the Federal Trade Commission. Heretofore, the orders of the Federal Trade Commission were not self-enforcing but it was necessary for the Commission to apply to one of the United States Circuit Courts of Appeals for an injunction, and when such an application was made the court had full power to review, affirm, modify, or set aside the order which the Commission sought to enforce. Under the new Act the party proceeded against has the right to appeal to one of the Circuit Courts of Appeals. However, if no appeal is taken within the prescribed time, or where the order of the Commission is affirmed by the courts, the order becomes final. Any person violating a final order of the Commission becomes liable to a civil penalty of $5000 for each violation, which may be recovered in a civil suit instituted by the United States. In brief, the new Act provides the Federal Trade Commission with real teeth.

Lyrical Mind

IN a recent suit for copyright infringement based upon the copyright of a popular song, the defendant contended that there should be no award for damages because the lyrics of the song were salacious. In support of its contention the defendant offered to introduce evidence as to the meaning of the words of the lyric, in the mind of the author. The court held that the meaning of the words to the author was immaterial and held that evidence bearing on this point should be excluded from the case.

Disclaimer

UNDER the patent statutes as construed by the courts, a patentee is required either promptly to file and prosecute an appeal or to file a disclaimer in the Patent Office, where one or more of the claims of his patent are declared invalid by a court of competent jurisdiction.

A disclaimer is a formal disavowal of those portions of the patent which really do not form part of the patented invention but were claimed in the patent through inadvertence, accident, or mistake. The failure to comply with the disclaimer statute as construed by the courts results in the patent being void and unenforceable.

In a recent suit for patent infringement the District Court held that one of the claims of the patent was invalid. The plaintiff filed an appeal to the Circuit Court of Appeals within the time prescribed by statute, but the defendant charged that the plaintiff failed diligently to prosecute the appeal, and contended that, accordingly, a disclaimer should have been filed in the Patent Office. The Court found that at about the time of the entry of the decree which adjudged the claim to be invalid the patent had expired. The Court pointed out that one of the purposes of the disclaimer statute was to relieve the public against an asserted monopolistic right which had been patented without justification. Since the patent had expired the public was not being subjected to any unwarranted claim for a monopoly and the Court concluded that the necessity for filing a disclaimer did not exist. In this connection the Court stated:

"A disclaimer filed immediately after entry of the decree could not have preserved to plaintiff anything to which he was justly entitled, nor relieved the public against an asserted monopolistic right which had been obtained without justification of fact. He had nothing to disclaim in which the public had an interest. A disclaimer would have been without effect, and it was not necessary."

RFC

ONE of the consequences flowing from the creation of the various agencies for the relief and aid of business during the depression is that the United States has become involved in a suit for unfair competition.

The Reconstruction Finance Corporation was created by special act of Congress for the purpose of aiding business, and the United States Government is the owner and holder of all of the capital stock of the corporation. In the normal conduct of its affairs the Reconstruction Finance Corporation loaned $250,000 to a shoe manufacturer and took as security liens on all of the real and personal property of the shoe manufacturer, including the right to use the corporate name, the good will of the business and all of its trade marks. Subsequently the shoe manufacturer went into bankruptcy, and to protect its interests the Reconstruction Finance Corporation purchased from the Trustee in Bankruptcy all of the real and personal property of the shoe manufacturer, including the business and good will, the trade marks, and the corporate name. Shortly thereafter two of the defendants in the suit under consideration organized a company for the manufacture and sale of shoes, represented that they were the successors of the original bankrupt shoe manufacturer, and employed the trade name and trade marks which were purchased by the Reconstruction Finance Corporation. The Reconstruction Finance Corporation then brought suit for unfair competition to restrain the use of the trade name and trade marks which it had purchased.

The defendants contended, among other things, that the Reconstruction Finance Corporation was not authorized to engage in business, that it had no business to protect, and that, accordingly, the acts of the defendants did not amount to unfair competition. The court disagreed with this contention, however, and held that the Reconstruction Finance Corporation had the right to make loans and to take security for loans, and that this necessarily gave the Reconstruction Finance Corporation the right to liquidate the security which it had received. The court held, further, that if the acts of the defendants in using the trade name and trade marks prevented the Reconstruction Finance Corporation from properly realizing on the security, the defendants were guilty of unfair competition. In reaching this conclusion the court stated:

"The plaintiff was authorized by law to make the loan and to take security for repayment. The authorization to take security implies the right to liquidate the security * * *. If by defendants' acts it is likely to be unfairly prevented from realizing what it has a right to expect from a sale of the business, the good will, and trade marks, the injury is present and redress may be sought in equity."

Books SELECTED BY THE EDITORS

MILESTONES IN MEDICINE

By Doctors Jeliffe, Stockard, Vogel, Tilney, Sigerist, Wayson, and Timme

THIS volume contains the recent series of laity lectures delivered through the New York Academy of Medicine by noted physicians. These are respectively on the historical background of psychiatry, the mechanisms of heredity, medicine at sea in the days of sail, the evolution of the human brain, the history of medical history, the history of leprosy, and the story of the glands of internal secretion. They vary considerably in interest and significance but all are easily understandable to average laymen. (276 pages, 5 by 8¼ inches, unillustrated.)—$2.15 postpaid.—*A. G. I.*

AN EXPERIMENT WITH TIME

By J. W. Dunne

THE fourth and greatly revised edition of a work that was first published in 1927 and which has since then been the subject of much discussion, pro and contra, among scientific persons. The author, an educated man, no muddled necromancer whether his work is true or false, discovered he frequently dreamed in advance many events that soon transpired with uncanny accuracy, and on prolonged study of these odd agreements he tried to work out a hypothesis of the nature of time. However, any persons who jump to the conclusion that this is any sort of "dream book," or work of occultism or other pseudoscientific hocus pocus of a too-familiar kind, will err. Whatever it is that Dunne has hit upon, it has been handled by him both scientifically and cautiously. The book is not easy reading except in spots, simply because the matters discussed are not light in kind. The author evidently can cut adrift from the present not only toward the past, as we all can, but sometimes along the future dimension of time, though not at will but only during sleep and not always even then. (297 pages, 5 by 7¾ inches, 21 drawings.)—$2.90 postpaid.—*A. G. I.*

PRINCIPLES OF MATHEMATICS

By Bertrand Russell, F. R. S.

IN 1903 the now famous Bertrand Russell of England published this book and it made his reputation as a great mathematician. This is the second edition of the same work and nothing in it has been changed because, as the author states, the original material is as clear today as it was a generation ago. Russell's fundamental thesis is that logic and mathematics are identical and that what is called mathematics is merely later deductions made from logical premises. This is no A B C book like Russell's "A B C of Atoms" and "A B C of Relativity," but is for the mathematically sophisticated, as some of the subjects dealt with in the respective chapters will show. These are: definition of pure mathematics, symbolic logic, implication and formal implication, denoting, classes, propositional functions, the variable, relations, the contradiction, number and cardinal numbers, addition and multiplication, finite and infinite, theory of finite numbers, addition of terms and addition of classes, whole and part, infinite wholes, ratios and fractions, meaning of magnitude, range of quantity, measurement, zero, infinity, the infinitesimal, continuity, genesis of series, meaning of order, asymmetrical relations. These give an idea of the first third of the book and the remainder deals with various aspects of order, infinity and continuity, space, matter and motion. (534 pages, 6 by 9 inches, unillustrated.)—$5.20 postpaid.—*A. G. I.*

SEASON OF BIRTH

By Ellsworth Huntington, Yale University

THE noted author of "The Pulse of Asia" and "Civilization and Climate" now turns to the question of the relation of season of birth to human abilities and offers to science a profound study of a question which might have made many an eyebrow raise until he has apparently proved that there really is a connection of this kind. However, astrologists and their ilk, in case they now discover in this a confirmation of occult notions, are likely to gain no comfort, for it is in no way tarred with such a stick and has nothing to do with any kind of holdover from mediaeval superstition. The author discusses season of birth, the effect of the birth *season* (not month, day, or hour) on length of life and on sex ratios, on leadership and on genius, also on numerous cognate matters. It is especially flattering if you discover that you were born right in season with the geniuses, especially if you are no genius. (473 pages, 5¼ by 8½ inches, 104 figures mostly graphs, and especially a fine bibliography.)—$3.70 postpaid.—*A. G. I.*

AIRCRAFT PROPELLER HANDBOOK

By Karl Hansson Falk

ENGINEERS, draftsmen, students, pilots, servicemen, and others in the aeronautic industry will find in the pages of this book concise and practical data which does not necessitate a large background of propeller theory. Where it is necessary to give equations they are presented in the most simplified possible form; advanced mathematics are employed only in a few cases where it is unavoidable. (100 pages, 6 by 8½ inches, numerous drawings and charts.)—$4.20 postpaid.—*A. P. P.*

THE LAW OF CHEMICAL PATENTS (Second Edition)

By Edward Thomas

THIS book, as the name indicates, deals with the law of patents as applied to chemicals and to chemical and industrial processes. The author approaches his problem in a rather unusual fashion. The book is not a textbook within the usual meaning of the word, setting forth a treatise on the development and present status of the law of chemical patents. It is rather a compilation of innumerable quotations from court decisions bearing on this subject. Thus each chapter is introduced by a paragraph or two of text written by the author, briefly outlining the subject matter to be covered in the chapter. The remainder of the chapter consists of a series of separate quotations from pertinent decisions. The book is exceedingly well indexed and can be used as a handy reference volume to locate decisions bearing upon the various questions in this field. (675 pages.)—$9.25 postpaid.—*D. H. Kane.*

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE

Fifth Edition

EVERY year we can count on a great expansion of this book, which was originally published five years ago as a rather thin volume. Last year we said that the Fourth Edition would give to the operating welder, to manufacturers, and to engineers practically everything they desired to know regarding design, procedure, and most effective utilization of this modern means of joining metals. We can only repeat that in this Fifth Edition the same holds true—with many additions. It is well illustrated with hundreds of pictures, drawings, and designs, and is bound in limp leatherette. (1012 pages, 6 by 9 inches.)—$1.50 postpaid.—*F. D. M.*

METEOROLOGY AS RELATED TO THE OPERATION OF AIRCRAFT

By Lieut. Harold Louis Kirby

A PRACTICAL flier and teacher of this subject of many years' standing, Lieut. Kirby has produced a concise, workmanlike text, splendidly illustrated. Kirby's meteorology should be an invaluable book for anyone concerned with weather forecasting, interpretation of maps, and practical meteorological work at an airport. No advanced theoretical treatment is presented but basic principles of meteorology—winds, clouds, weather maps, sudden storms, and meteorological instruments—are frequently and adequately discussed. (120 pages, 50 illustrations.)—$4.20 postpaid.—*A. K.*

A HISTORY OF LAND MAMMALS IN THE WESTERN HEMISPHERE

By William Berryman Scott, Prof. Emer. of Geology, Princeton University

THE second edition, revised and rewritten throughout, of a work which has been a landmark among students of the evolution of the mammals of our western world. The author is a noted paleontologist. For final and authentic scientific book data on the extinct mammals, gigantic and small—on the great elephants, primitive horses, the odd meropus, the uintathere, the toxodon, saber-tooth tiger, and the whole immense host of bizarre new-world warm-blooded

beasts—this textbook is the last word. Not written to entertain, it is strictly a scientific book requiring study and collateral reading. The many illustrations of the great extinct mammals, made by artists who also understand paleontology, are remarkably fine. (786 pages, 5½ by 8¼ inches, 420 illustrations.)—$7.75 postpaid.—*A. G. I.*

MOONS, MYTHS AND MAN

By H. S. Bellamy

THE author is a Viennese collector of myths, many of which concern supposed early race-memories of vast catastrophic cosmic events—deluges and awful destructions such as that of the "lost continent" of Atlantis—and the greater part of this book is a collection of such myths. When the author, after years of such collecting and saturation in mythology, heard of a hypothesis proposed by an Austrian machine builder named Hoerbiger, who believes, among other things, that the moon is a metallo-mineral sphere enclosed in a 135-mile deep jacket of ice and was captured by our planet some 14,000 years ago, he linked up this man's hypothesis to his own collection of myths. The hypothetical events of that period were what started the myths, he thinks—and thus we have this bizarre book. At that, it makes fascinating reading, and it is decidedly well written—not a narrative, not scientific fiction, but straight exposition. However, the reader is warned that the hypotheses presented in it are without standing in the world of science. (351 pages, 5 by 8 inches, 9 illustrations.)—$2.65 postpaid.—*A. G. I.*

LOST ATLANTIS

By James Bramwell

THIS book represents an effort to examine the evidence for Atlantis and, while the author is clearly a pro-Atlantean, he exhibits at least to some extent the scientist's critical faculty. "It may well be admitted," he states, "that the balance of responsible scientific opinion is against Atlantis ever having existed at all." "Balance" here seems to be a charitable word. Similarly, he makes common cause with the scientist against various kinds of occultists who accept Atlantis as a matter of course or of emotion. Elsewhere, however, the book shows heavy leanings toward the romantic. Yet, to the scientific reader who is interested in seeing what there is to "all this recently revived Atlantis business," this would seem to be a much more sensible—or at least less nonsensical—book than the one in the previous review. (288 pages, 5¼ by 8 inches, one map.) $2.90 postpaid.—*A. G. I.*

EARTH-LORE

By Professor S. J. Shand

"GEOLOGY Without Jargon" is the subtitle of this brief but compact book which is the first American edition of a work that received flattering notice from scientists when it was published not long since in England. Jargon—special geological terminology which only the specialist really needs to remember—has previously stood as a high prison wall to keep the science within the narrow confines of the geologist's own group, a fact most regretted by the geologists themselves. Professor Shand goes as far as it is possible to go toward explaining about geology without asking his reader first to master an immense glossary of the specialist's terms. A newly added chapter on Atlantis, Mu, and other "lost continents" sets the reader straight about these myths so beloved by the incurably romantic who would identify human legends a mere few thousands of years of age with geologic events that took place many millions of years ago or else not at all. "There is no valid reason to believe that any 'lost continent' has existed either in the Atlantic or in the Pacific since man appeared on the earth," he says, and the other geologists agree with him. (144 pages, 5 by 8 inches, 49 illustrations.)—$1.90 postpaid.—*A. G. I.*

We can supply our readers with any of the books reviewed in this department. Prices quoted include domestic postage. Foreign prices are necessarily higher due to increased shipping charges.

SCIENTIFIC AMERICAN
24 West 40th Street New York, N. Y.

FLAME

By Oliver C. de C. Ellis and William A. Kirkby

A MONOGRAPH which starts with the study of a candle flame and proceeds to give the complete physics of flame. Some of the section headings are: Rise of Pressure, Convection and Gravitation, the Registration of Motion, the Fundamental Speed of Flame, Reaction Velocity, Thermal Conductivity, Detonation, Mechanism of Ignition, Phosphorescent Flames, and Spectrography of Flame. These are only a few of the subheads, to indicate the highly technical nature of this volume which is of convenient pocket size. (136 pages, 4½ by 7 inches.)—$1.35 postpaid.—*F. D. M.*

ASCARIS

By Dr. Richard Goldschmidt, University of California

THE story of life, as told by a noted biologist. It gives the gist of biology in readable form and one which presupposes no previous scientific knowledge. This book has been well-spoken of among men of science. (390 pages, 5½ by 8 inches, 160 illustrations.)—$3.40 postpaid.—*A. G. I.*

FAMOUS MEN OF SCIENCE

By Sarah K. Bolton

THE 16th printing of a book which was first published in 1889, hence the book has been through the purifying fires. Today it appears in modern typography and binding, with added chapters on Edison, the Curies, and Marconi. The chapters give narratives or portraits of the lives of Copernicus, Galilei, Newton, Linnaeus, W. Herschel, Cuvier, von Humboldt, Davy, Audubon, Faraday, Lyell, Agassiz, Darwin, Pasteur, Fabre, Kelvin, Huxley, and those previously named. While not juvenile, it is perhaps best suited to reading by youths in their teens, because the lives are described in such a way that the young reader is likely to wish to emulate and choose science as a vocation. (376 pages, 5¼ by 7¾ inches, with illustrations of the subjects of the silhouettes.)—$2.15 postpaid.—*A. G. I.*

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WELDING

SCIENTIFIC AMERICAN ADVERTISERS

June · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York
ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 158, No. 6, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

HIGHWAY ACCIDENTS!

Complete

SCIENTIFIC AMERICAN

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS · JULY · 1938

18985

FLEET maneuvers and close study of airplane operations in the world's current wars have shown the capabilities and limitations of aircraft in naval use. Thus in recent years, officers and men of the U. S. Navy have become more and more air-minded, and today all are convinced that aircraft are as definitely a part of the fleet as are surface and sub-surface units. Captain Ingram makes this clear in his article on page 9. Our cover photograph—Official, U. S. Navy—symbolizes the close co-ordination between air and sea units.

SCIENTIFIC AMERICAN, July, 1938. Vol. No. 159, No. 1, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year, Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

(Condensed From Issues of July, 1888)

AIR CORPS—"The French squadron, now gathering at Toulon for the regular summer evolutions, has with it an aerostatic corps charged with work of a wholly novel kind. Captive balloons are to be sent up from the ships to heights of 300 meters—about 1,000 feet— . . . A topographer will go up with the balloon to make a sketch of the underlying country, with special reference to roads and woods or the position of a supposititious enemy."

GRAPHOPHONE—"The graphophone, which is shown in the annexed engraving, is, as its name indicates, a recorder and reproducer of sounds. It is the invention of Mr. Charles Sumner Tainter, and is the result of several years' experimentation and the subject of many patents, several of which were issued in May, 1886. In its construction, efficiency has, of course, been the first consideration, after which the matters of simplicity, facility of management, and the practical handling of the records or messages have been disposed of. The machine is an exceedingly simple thing. . . . The record cylinder consists of paper wound in a peculiar way, to cause it to maintain its cylindrical form, the outer surface of the paper being coated with a specially prepared wax. . . . The groove constituting the record is microscopic in size, it being only three thousandths of an inch wide and about two thousandths deep. One hundred and sixty grooves to the inch are cut on the cylinder. . . . The machine is driven by connection with any power having a fairly uniform speed. In the engraving the machine is represented as being driven by a small electric motor."

IN THE HAREM—"The women in the Sultan's seraglio, at Constantinople, have just been vaccinated, to the number of 150. The operation took place in a large hall, under the superintendence of four gigantic eunuchs. The Italian surgeon to whom the task was confided was stationed in front of a huge screen, and the women were concealed behind it. A hole had been made in the center of the screen, just large enough to allow an arm to pass through."

PAPER ORGAN—"A very original musical instrument has recently been constructed at Milan—an organ whose pipes, instead of being of metal, are of paper pulp. . . . It is generally agreed that the instrument possesses great power, and a sweetness of tone not found in organs hitherto constructed."

STEEL—"The United States and Great Britain produced last year three-fourths of the steel and two-thirds of the iron made and consumed among enlightened nations. The pig iron output was 20,820,771 tons, of which Great Britain produced 7,441,927 tons and the United States 6,417,148 tons."

SPEED—"The first specially fast express train ever run was in 1846, on the Great Western road . . . known as the 'Flying Dutchman,' which name it has since retained. It made the distance of 193 miles from London to Exeter in four and a half hours, with five stops, the full running speed of the train between stations being at the rate of 63.9 miles per hour. . . . One of the best authenticated tests of locomotive performance was a trial in 1885, over the Bound Brook route from Jersey City. In this test . . . the indicator cards gave a speed as high as a mile in 46 seconds, or equal to 78.26 miles per hour."

ATLANTIS—"The Dominion steamer Alert recently left Halifax, N. S., with men and material for the erection of a lighthouse, for the third time, on the west end of Sable Island. . . . The rapid disappearance of this remarkable island is one of the present marvels of the North Atlantic. Year by year it lessens in extent, threatening soon to be submerged, and its existence at no distant day promises to be as great a mystery as the location of the mythical Atlantis."

SIGNALLING—"Admiral Sir W. Hunt Grubbe has recently made some interesting experiments at the Cape of Good Hope on the sending of signals by means of the rays of an arc lamp reflected by the clouds. The luminous fascicle from a 100,000 candlepower arc lamp was directed against the clouds by means of a reflector, and interrupted according to the heliographic code. The dispatch could be read with ease at Cape Town."

CROTON—"The great aqueduct for carrying the water of the Croton River basin to the metropolis, in quantity adequate to supply its wants for years to come, is now fast approaching completion."

CASH—"Machines for registering the amount of cash received are among the new appurtenances of well regulated retail establishments in this city. The operator presses a key, which turns the register, counts and records the amount paid into the money drawer. When the day's work is done, the machine shows the total amount of cash received, and the cash in the drawer should correspond with the figures on the register."

METRIC—"Ten mills make one cent, ten cents make one dime, ten dimes make one dollar, ten dollars make one eagle. This is the metric or decimal system. It is easily understood by everybody, has been in use, in respect to our coinage, ever since the foundation of the government. How desirable it is that it should be substituted for the old system in all our expressions of weights and measures."

BRAKE—"A marine brake has been invented by M. Pagan, and was recently tested on the Seine. It consists of a cable having attached to it a series of canvas cones which open out by the action of the water, and exert an enormous retarding force on the vessel. Thus the steamer Corsaire, running at a speed of 13 knots, was stopped by this appliance in 7 seconds, 34 seconds being required when she stopped by reversing the engines without making use of the brake."

AND NOW FOR THE FUTURE

The tales that skeletons tell, by Prof. Wilton Marion Krogman.

Weight tips the scales of industry, by Roger William Riis.

High pressures and their effects on the properties of matter, by Prof. P. W. Bridgman.

Can commercial diamonds be made synthetically?, by Lewellyn D. Lloyd.

Personalities in Industry

PAUL DYER MERICA

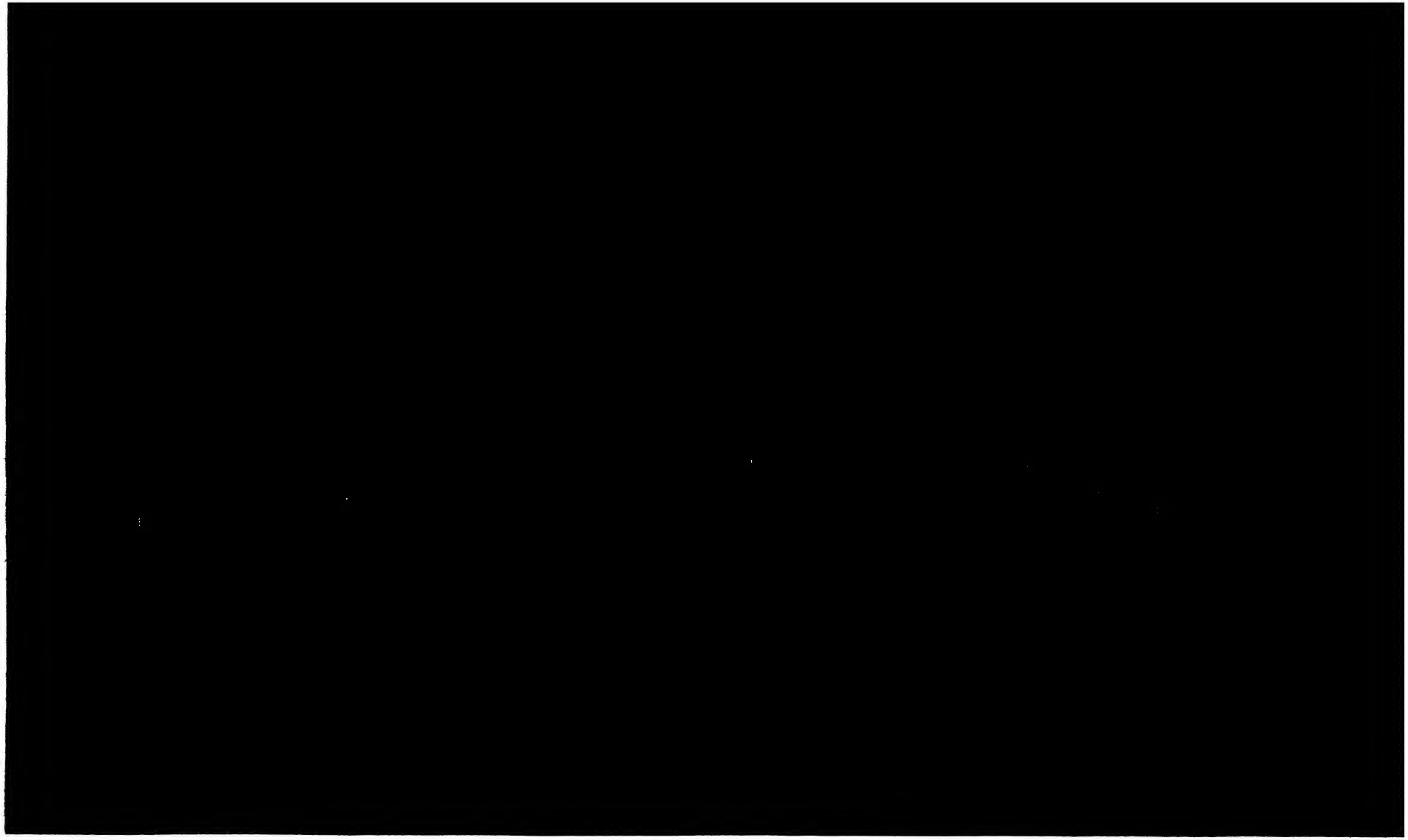
NOT only industry but professional groups as well have a responsibility in developing a real public understanding "as to the nature and value of the technological gifts which society is continually receiving," according to Dr. Paul Dyer Merica, who shares with the late Marconi the distinction of being one of the two youngest men ever to have received the John Fritz Medal. Awarded annually by the four major engineering societies of the United States, this medal was conferred on Dr. Merica recently on the occasion of his forty-ninth birthday, the citation being in "recognition of important contributions to the development of alloys for industrial uses."

Dr. Merica has come to this honor and has evolved this sense of the professional man's responsibility to the public through a distinguished career which has included both the seclusion of research and testing laboratories and the hurly-burly of industrial conference and direction. A native of Warsaw, Indiana, he studied first at De Pauw University and then at the University of Wisconsin which granted him an A.B. degree in 1908. Chinese friends whom he made while at Madison interested him in teaching "Western subjects" in the Chekiang provincial college at Hangchow. Going to China in 1909, he spent the next two years there, and it was during this period that he introduced laboratory instruction in chemistry and physics.

Matriculating at the University of Berlin in the autumn of 1911, he received his doctorate *magna cum laude* three years later. This German experience included study of electrochemistry and metallography in the Technische Hochschule at Charlottenburg. Dr. Merica later returned to the United States to join Dr. G. K. Burgess in the newly organized Division of Metallurgy of the U. S. Bureau of Standards. His arrival in Washington coincided with the outbreak of the World War, and the resulting interest in light alloys for aircraft construction led to his study of aluminum alloys and thus to his remarkable discovery of the mechanism whereby quenched duraluminum hardened on merely standing for a time at room temperature. This research, which has been described as "the metallurgical shot heard 'round the world," led to the formulation of a general law of precipitation hardening and was subsequently found to apply to a wide range of steels and alloys.

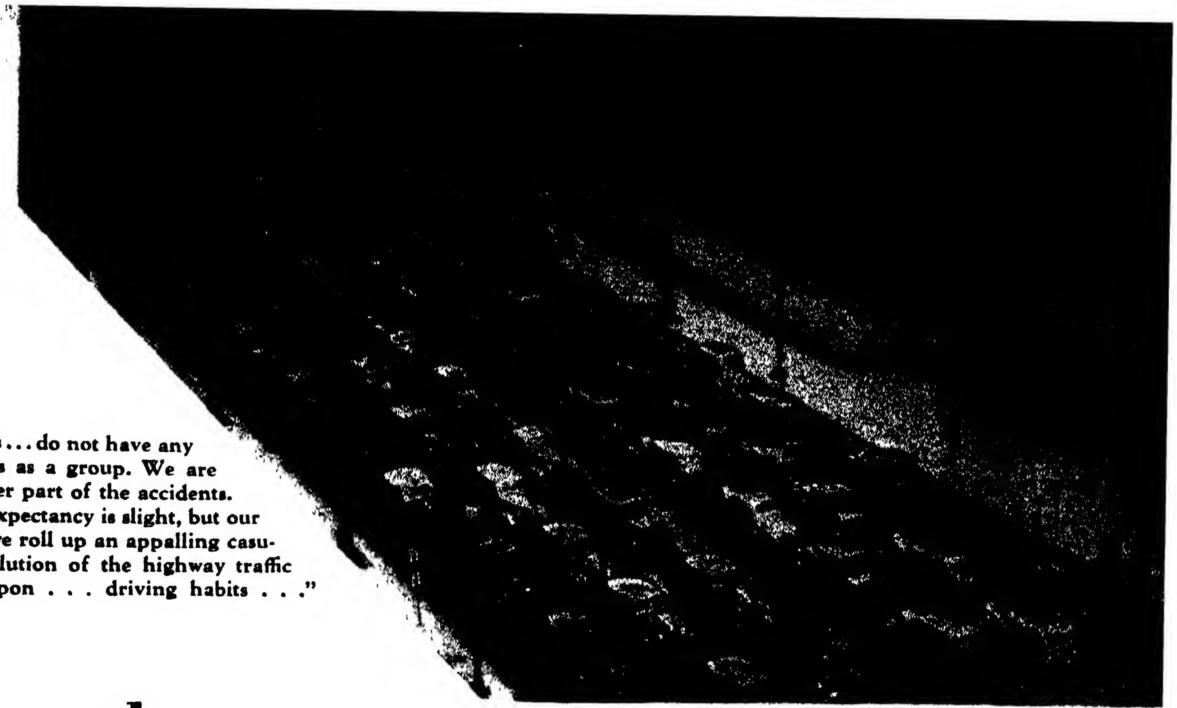
But Dr. Merica's work during his five years at the Bureau of Standards was by no means limited to the metallurgy of aluminum. He correctly diagnosed the metal failure in the disastrous explosion of a boiler on the S.S. *Jefferson* and prescribed methods for eliminating the hazard. He successfully tackled the problem of spontaneous failure through stress corrosion of the brass valve stems used in the Catskill Aqueduct. To provide a background for the study of rail and similar failures in the United States, he made a comprehensive study of foreign specifications for materials used in railroad construction work.

Dr. Merica's transition into the world of industry came in 1919 when he was offered a position in the physical laboratory of the International Nickel Company at Bayonne, New Jersey. There he first devoted himself to improving the melting practices employed for nickel and Monel and to other plant problems. Then, in 1922, he was brought to the New York office of the company as assistant manager of the development and research department which was being established to find industrial uses for nickel and its alloys. As director of research for this department, he laid the groundwork for the present development of alloy cast irons and for improvements in the physical properties of the nickel-copper alloys of the Monel type. Becoming technical assistant to the president in 1930, he developed the series of Nickel Information Bureaus in world industrial centers for better co-operation between industry and research. In 1935 he was elected a director of the company, and a year later he became a vice-president.



NIGHT SAFETY ACHIEVED WITH BUTTONS

AROUND the curve and over the hill, the highway edge is picked out, for hundreds of yards ahead, by the glow of one's own car's headlights reflected from simple button reflectors made of the plastic Lucite. The installation shown above, and discussed in the Digest section of this issue, was made on a highway between Detroit and Lansing, Michigan. The driver does not have to guess the location of the highway.



Courtesy
U. S. Bureau of Public Roads

"...the great majority of us...do not have any salient traffic characteristics as a group. We are the ones who have the larger part of the accidents. Individually our accident expectancy is slight, but our numbers are so great that we roll up an appalling casualty total. The ultimate solution of the highway traffic safety problem depends upon . . . driving habits . . ."

Who Have the HIGHWAY ACCIDENTS?

By
R. W. CRUM
Director, Highway Research Board

Three Groups of Drivers . . . By No Means a Hopeless Prospect . . . Good Teaching Produces Safe Drivers . . . The Key to Accident Prevention

THE driver is the key to the traffic accident problem. Without his wrong acts there could be few accidents. The sole responsibility is not his, but everything that is done in the interests of safety must be based upon the effects upon drivers' behavior. Builders of vehicles and roads must share the responsibility, but they must take drivers' characteristics into account.

The driving population may be divided into three significant classes: A relatively small group of high-accident individuals, a larger group of comparatively accident-free persons, and the majority of the drivers among whom are those who have the bulk of the accidents without being especially susceptible by reason of proneness to accidents or lack of experience.

It has long been known that certain persons are prone to have mishaps while driving motor vehicles. It may not always be possible to show definitely that they are responsible for particular accidents, but for some reason they have the unhappy faculty of being on hand when such things happen. Although there has been extensive popular supposition that such accident-prone individuals are responsible for a major part of the accidents, there has been no certain knowledge of the relative number of them in the whole driving population.

In order to discover the facts of this situation and in the hope that the information secured might point the way to some effective measures for combatting the rising tide of highway traffic casualties, the Highway Research Board and the U. S. Bureau of Public Roads in co-operation with the Commissioner of Motor Vehicles of Connecticut studied the accident records of 29,531 Connecticut drivers, selected at random, for the six-year period 1931-1936. In the six-year period these 29,531 drivers had 7082 reported accidents. However, 23-881 drivers had no accidents and 4503 had one accident, leaving only 1147 who had two to seven accidents each. Nineteen percent of the drivers had all the accidents and only 3.9 percent repeated within the six years.

IF the 7082 accidents had been distributed impartially among the 29,531 drivers without regard to personal identities or histories, it can be computed mathematically, on the assumption that the accident rate per operator is a constant, that 23,234 would not have had an accident, 5572 would have.had only one accident and 725 would have had two or more accidents. Since the accidents did not occur in this way it is apparent that they were not distributed by chance but that the distribution must have been affected by some systematic influences.

There were 647 more drivers who had no accident than could be accounted for by chance and 1069 fewer drivers who had only one accident than could be accounted for by chance. The better-than-to-be-expected results in these two groups indicate that there must be a fairly large group of drivers in the population who are more than ordinarily free from traffic accidents.

On the other hand, the fact that there were 422 more accident repeaters than expected indicates the presence of a smaller group who for one reason or another are more than ordinarily susceptible to traffic accidents. This excess may be taken as a measure of the relative proportion of really accident-susceptible drivers. Thus, in the six-year period studied, 1.5 percent of the population who had about 15 percent of the accidents appeared to be accident prone. With longer experience this figure might increase but it is hardly to be expected that many truly accident-prone individuals would stay unrevealed for six years.

Since the comparison of the actual number of accidents in each group with the expected number was based on chance distribution without regard to identities or histories of the drivers, the accident-prone group thus defined may contain some individuals who are more than ordinarily susceptible to accidents on account of excessive exposure to hazards, in addition to those who have an inherent tendency that way. These can,

Courtesy American Automobile Association

Training by doing. Interior of a driver-training car, showing dual pedals by means of which an instructor can maintain control of the car if the student should become panic stricken

of course, be segregated by further investigation; in any case they constitute a dangerous element.

Between the accident prone at one end and the fortunate ones at the other are the great majority of us who do not have any salient traffic characteristics as a group. We are the ones who have the larger part of the accidents. Individually our accident expectancy is slight, but our numbers are so great that we roll up an appalling casualty total. *The ultimate solution of the highway traffic safety problem depends upon the driving habits we develop and upon the attitudes we take toward our responsibilities.*

ANOTHER significant fact disclosed by the investigation is that the younger drivers—16 to 25 years old—have nearly twice as many accidents as would be their share in proportion to their number in the population. Of the 7082 recorded accidents of 29,531 Connecticut drivers during 1931-1936, the drivers younger than 25 years had 1.83 times as many fatal accidents, 1.53 times as many non-fatal personal injury accidents, and 1.47 times as many property damage accidents as might have been expected from their relative number.

There were 2467 drivers involved in fatal accidents in Connecticut during 1932 through 1936. Of these, 316 were less than 21 years of age and had 1.72 times their share of the accidents. In eight yearly samples studied from Massachusetts and Connecticut the drivers under 21 had from 1.24 to 2.10 times their share of fatal accidents.

The net result of these studies has been to point out three groups in the driving population toward which corrective measures should be directed: (1) The accident prone; (2) The younger drivers; (3) The great majority who are not accident prone nor susceptible to accidents because of lack of experience.

What of the accident prone? Before anything can be done to protect us against the accident-prone driver he must be identified as an individual, because in the nature of things this problem calls for clinical approach rather than general educational methods. These people probably think they are careful in spite of their bad records, and that their mishaps are due to the faulty acts of others. But waiting for the persistently bad driver to reveal himself through a series of costly accidents is at best a poor expedient: The hope is that some means may be found for determining a person's driving proclivities in advance.

Tests for individuals have been developed, notably by Lauer at Iowa State College and DeSilva at the Harvard Bureau for Street Traffic Research, to such a point that it is possible to determine a person's relation to the average for a number of traits that presumably should have some influence upon his ability to drive a motor vehicle safely. In theory a person's ability with respect to such attributes as hearing, seeing, resistance to glare, angle of vision, reaction time, coördination, color blindness, physical handicaps, intelligence, and others should give some indication of his potential ability as a driver. Through the co-operation of Dr. Lauer, Dr. DeSilva and Michael A. Connor, Connecticut Commissioner of Motor Vehicles, we recently applied the tests to about 3000 drivers with ascertainable records. It is hardly to be expected that any one test will give a reasonable estimate of general ability to drive safely, and our data in the present incomplete state of analysis seem to bear this out.

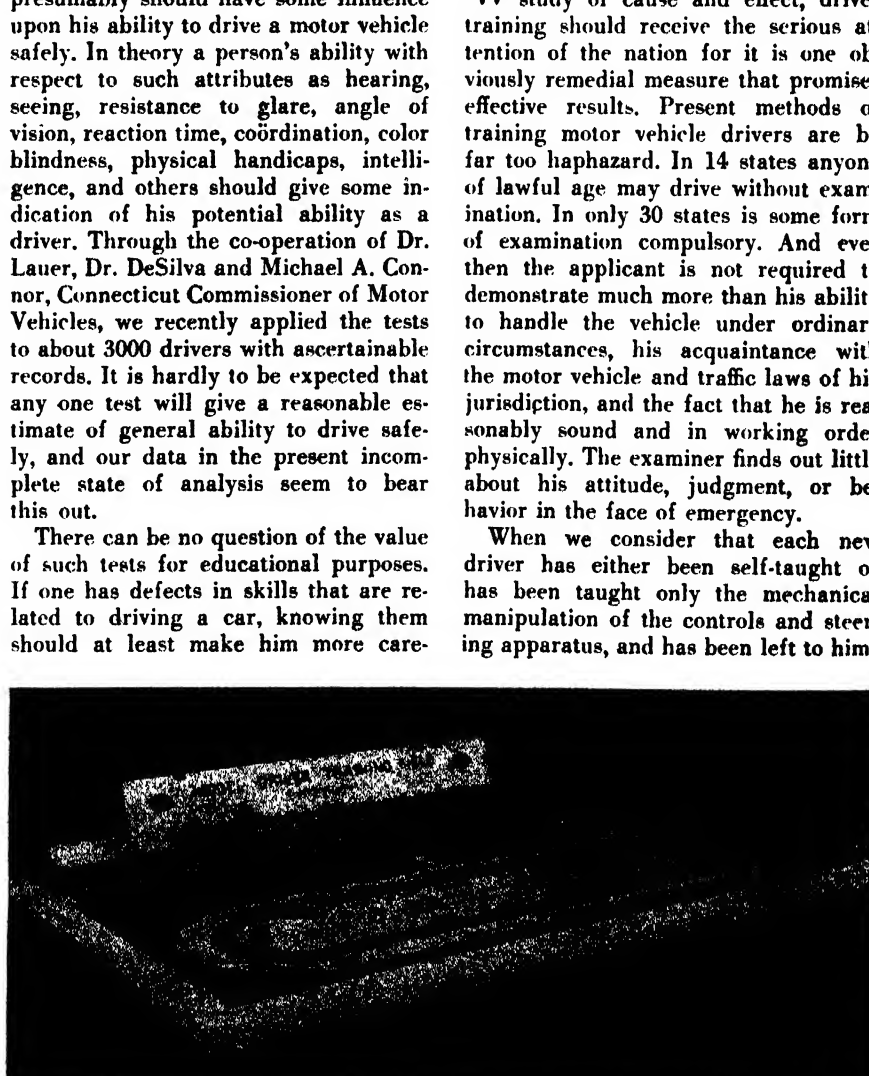
There can be no question of the value of such tests for educational purposes. If one has defects in skills that are related to driving a car, knowing them should at least make him more careful and thoughtful about his driving habits. But even after the accident-prone individuals are identified, there must be a third separation: Those of the accident prone who are amenable to re-education must be separated from the incorrigibles.

When this point is reached we will be ready to act. Those whose hazardous tendencies can be corrected may be reclaimed; the others must be eliminated from highway traffic. This is by no means a hopeless prospect. Much has been gained when the avenues for research are so clearly indicated.

The youthful drivers constitute a group we can go to work on right away. We know who they are and where to find them. We do not know from statistical data whether the principal factor in their bad record is lack of experience, immature judgment, excessive exposure, or lack of proper training. There is, of course, no substitute for experience, but immaturity can be corrected by time and certainly poor training can be changed for the better.

WITHOUT waiting upon further study of cause and effect, driver training should receive the serious attention of the nation for it is one obviously remedial measure that promises effective results. Present methods of training motor vehicle drivers are by far too haphazard. In 14 states anyone of lawful age may drive without examination. In only 30 states is some form of examination compulsory. And even then the applicant is not required to demonstrate much more than his ability to handle the vehicle under ordinary circumstances, his acquaintance with the motor vehicle and traffic laws of his jurisdiction, and the fact that he is reasonably sound and in working order physically. The examiner finds out little about his attitude, judgment, or behavior in the face of emergency.

When we consider that each new driver has either been self-taught or has been taught only the mechanical manipulation of the controls and steering apparatus, and has been left to him-



A step in the right direction. Model of a driver-training field, where the novice can make mistakes to his heart's content, without endangering lives of others

self to develop his real driving technique and attitude, is it any wonder that bad driving habits so often have their effects at crucial moments?

The hope and necessity for the future lies in teaching the boys and girls how to drive correctly as they come to driving age. Much is already known about what to teach and how to teach it. Professor Heyhart of Pennsylvania State College has demonstrated that *good teaching produces safe drivers.* The big problem is one of ways and means: What agencies should give the instruction? Where should it be given? How should a tie-in with the licensing authority be effected? What provision should be made for practice grounds?

It should be apparent by now that there is no cure-all for traffic ills, and this becomes even more certain when we examine the great unclassified group. Even if the accident-prone group could be liquidated altogether the larger and tougher part of the problem would still remain. What can be done to lower the accident level for the great majority of the drivers? Make the vehicles and roads as safe as possible for reasonable use; in some way instill into the whole population a knowledge of better driving practice; arouse all drivers to a less individualistic attitude and to an assumption of greater personal responsibility. Most of us drive prudently most of the time but enough of us do wrong things every day to kill 100 people, to say nothing of injuries and damage to property.

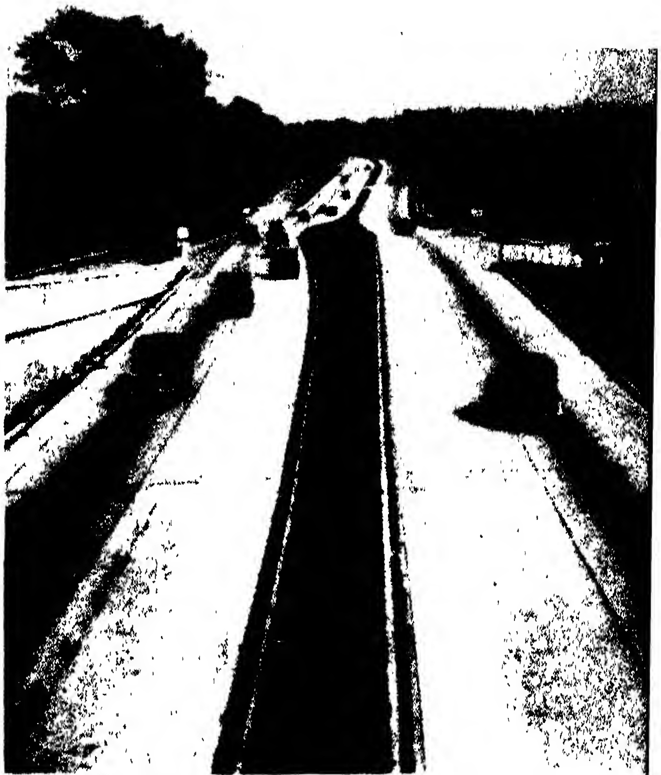
As a class we are collectively horrified at the situation, but individually we are indifferent because we do not expect to have an accident ourselves and, drunk or sober, we are convinced we are good drivers. This is a serious fact that must be taken into account.

There is another compelling reason why the proper training of new drivers is so important. If all new drivers could be properly trained as they arrive it would take only 25 or 30 years to clear up the whole problem of driver education. When adequate training facilities are provided, their use should not be restricted to new drivers. The motor-vehicle administrators will find many who need retraining and many older operators will welcome an opportunity thus to improve their driving habits.

In the meanwhile, of course, the educational efforts being made by towns, cities, states, and many public spirited organizations must be supported and encouraged. Results, though perhaps slow in appearing, must ensue.

It would help if we could all adopt the frame of mind that we must be in some way at fault ourselves whenever we get into a risky situation or are involved in even a minor mishap. There is considerable truth in the thought: "Good drivers do not get into tight places." Some people can adopt such a judicial attitude toward their own acts; for others it is difficult and for many it is mentally impossible. Nevertheless the point is worth making.

". . . The driver is entitled to roads that are safe for reasonable use . . ." A divided highway on which the drivers are protected by separation of traffic in opposite directions



Courtesy Massachusetts State Highway Department

Much can be done to lower the accident rate through control of traffic, but there is urgent need for unification of practice throughout the nation. The driver is entitled to uniform rules, regulations, and practices in everything that affects driving habits: He is entitled to freedom from conflicting and meaningless laws and regulations. When these conditions prevail universally it will be reasonable to expect wide-spread improvement.

Law enforcement is a necessary adjunct to traffic control but it is axiomatic that no law affecting the entire population can be enforced without popular support. It follows, therefore, that regulatory measures that are needed for safety must be sold to the public. Remarkable results have been secured in Evanston, Illinois, and several other cities by using police power from the standpoint of accident prevention; through this type of activity the law-enforcement agencies may contribute much toward lowering the accident rate. Drivers en masse do not seem to be influenced much by reading in the papers the record of arrests, convictions, and license revocations, but most of us can be impressed into carefulness by frequent sight of uniformed policemen. More patrolmen on the road should have salutary effects.

The biggest objective is to get the drivers trained so that they will instinctively do the right things, and thus avoid conflict with the law.

This is the story about the driver but it cannot be ended without noting that the responsibility is not all his. The other three factors—vehicle, road and man on foot—must be brought into proper relation with safety before the job will be done.

It is perhaps needless to say that the driver is entitled to a vehicle which is originally safe for reasonable use, and that thereafter he has a responsibility to others as well as to himself to keep it in safe condition.

The victims of two out of five traffic accident deaths are pedestrians and in a large proportion of the reported cases they are at fault. A significant fact is that of 1238 pedestrians killed in Connecticut during 1932-1936 inclusive, only 48 were operators of motor vehicles. This shows the necessity of impressing upon the non-driving public the difficulties of handling motor cars in heavy traffic and the fact that although a walker can clearly see an approaching vehicle, conditions may be such that the driver may not see him. It is quite possible that a man may be within the visibility range of a car's headlights and still the driver may actually not see him until it is too late.

The driver is entitled to roads that are safe for reasonable use, and he is entitled to some measure of protection against the hazards beyond his control—the acts of other drivers, acts of pedestrians, and blind intersections. He is entitled to a national system of signs and signals, the meanings of which are exact and unmistakable.

Enough has been said to show that the lowering of the accident level is a task of great magnitude, but not an impossible one. It will take continuous and widespread concerted effort for a long time. Speeds are too great, vehicles too mobile, and men too fallible for us to expect entire freedom from accidents, but it is self-evident that the accident rate is far above an inevitable minimum.

OUR POINT OF VIEW

Changed Conditions

THAT the airplane has pushed the first line of defense of our shores 500 to 1000 miles out to sea, Captain Jonas H. Ingram clearly shows in his article beginning on the opposite page. That it has voided the protection of the "narrow seas" for Great Britain is pointed out in a lengthy editorial in our conservative contemporary, *The Engineer*, of London.

With ill-concealed longing for the days—centuries of them—when Britain's policy "could be different from that of every other European power," the editorial reviews the changes that have been wrought since the World War, and ends on a note of what might be called optimistic resignation: too bad it had to happen this way but let's be cheerful, become acclimatized, and learn to carry on efficiently. "After living for nearly nine centuries in a land which had never been invaded, a land armed and protected by the sea, we are now obliged to recognize that our island is vulnerable and to accommodate ourselves to a new state in which the possibility of hostile attack must constantly be envisaged. . . . We are become as the rest of Europe; a country with violable frontiers. That is a condition which we do not fully comprehend; in time we shall become accustomed to it as men become accustomed to a singing in the ears and cease to notice it. We must remember, too—it appears to be often forgotten—that the effect is reciprocal. . . . If a continental army could strike at us in an hour or two, it is equally true that we could strike at it. If armadas of the air have brought for us a new danger, they have for other European powers increased an old one, thus augmenting their anxieties." There is much too much for quotation here, but we might add this from the conclusion: "But when we have grown accustomed to it, when it is just as much of our normal existence as it is now of all European powers, we shall pursue our course hardly aware of it."

Here is British composure in concerned mood. Changed conditions, indeed! Almost too long did the British wait; and now they find themselves faced with a problem difficult for them to understand. They had, therefore, to revamp, almost overnight, their armaments program and simultaneously devise a new approach to international problems. Would not this situation explain the mystery of some of the recent commitments and political maneuvering of Britain's international experts?

In expressing the hope that Britain will, as usual, find her way safely out of the morass, let us not be too cocksure about our own position. Britain's situation teaches its lessons. We, too, have waited almost too long. Until very recently, we had built comparatively few new naval vessels, had neglected our defenses. Our frontiers may not be violable as are Britain's, but that "first line of defense" has been our pet delusion for years, it has been very lame. Perhaps planes may not for years—or decades—violate our continental frontiers, but sooner or later such a possibility must be faced. In the meantime, our sea frontiers—vital to our continued peaceful existence and well-being—must be reinforced by new ships of the sea and air lest some daring aggressor covet them. Our new naval building program and the air-mindedness of the brains of the Navy, which Captain Ingram discusses, constitute a splendid start toward taking up the lag and helping us out of our own morass—of self-sufficiency and vaunted invulnerability—in which we wallowed for years.—*F. D. M.*

Creakily We Move Along

IF someone has been in an accident and lost an arm or a leg, it never occurs to others to regard him with different esteem than before. Luck was to blame and the same ill luck might have hit any of us.

Similarly, if one has lost the use of one of his senses, people do not think of holding this against him—why should they? To do so would be crazy. Apropos of this, in that delightfully frank and honest book, "Louder Please," Elmo Calkins has pointed out the rational attitude toward deafness. Himself deaf, he sees no reason for hiding it, he says.

Or suppose one of our internal organs has gone out of whack, no one then dreams of blaming us, for we deserve no censure.

Now suppose another internal organ, the brain, ceases to function properly. We call this insanity and for some reason we seem to regard this organ's dysfunction uniquely in the light of something akin to disgrace. Physicians tell us the last fact they can pry out of their patients is the existence of insanity in their families. Not, however, that this attitude on the part of the individual is irrational. Indeed, it is an entirely logical and necessary defense against a world which seems to regard insanity as blameworthy or at best in an exaggerated light. Here, it is the world itself which is possibly a little bit "insane."

Because a coming newer enlightenment is thereby indicated, it is encouraging to learn that cured mental patients in Illinois are now forming an association of former patients of psychiatric institutions, and will engage in a public educational campaign for the purpose of changing the attitude of the community toward mental disease. We offer them our comments as a contribution to that campaign.

There was a time not very long ago when the insane were punished. Today we look upon this odd attitude with horror, but we incline to think of our own modern attitude as enlightened. Perhaps, however, it is not even yet quite so fully enlightened as we appear to think it is.—*A. G. I.*

Today—Tomorrow

AN event of vast significance for the future was witnessed late in May by a large group of educators, publishers, and others vitally interested in the promotion of cultural activities. At that time was dedicated, at Oglethorpe University, Atlanta, Georgia, a crypt in which is to be sealed, for 6000 years to come, a comprehensive record of the civilization of today. A far distant generation will be the beneficiary.

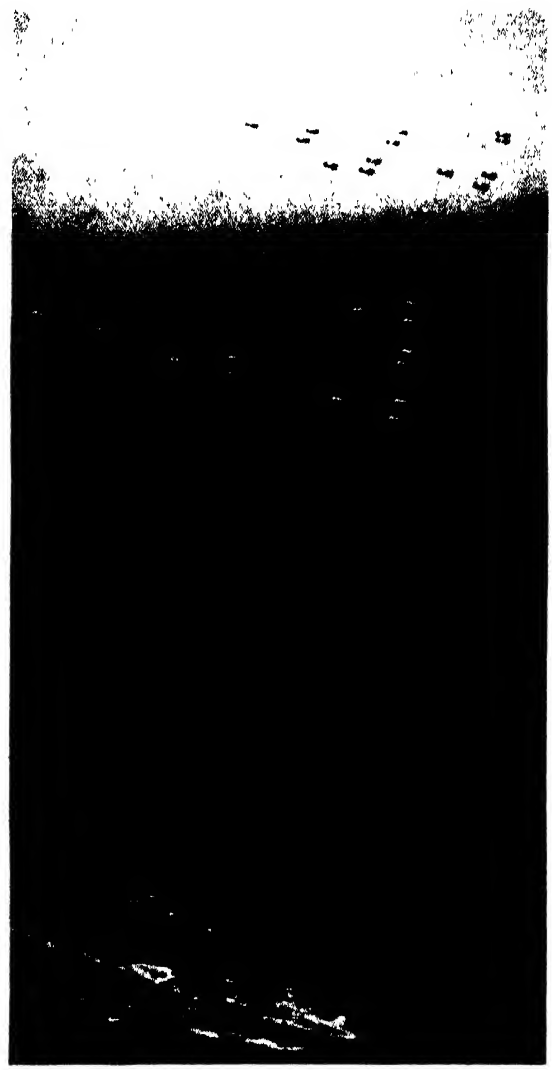
Every possible contingency has been foreseen in planning this gift to future archeologists. Far-reaching and worldwide changes will take place while these records lie untouched, ready to spread their information to an unknown people of the future. It is possible, indeed, that the language of that distant time may not be English; even this possibility has been considered and steps have been taken to make available lessons in English for a people which may have lost all record of our present tongue.

First proposed through Scientific American by Dr. Thornwell Jacobs, President of Oglethorpe University, the idea of providing such a sealed and guarded history of our age has rapidly gained momentum. The list of individuals and organizations which will contribute to the success of the project is much too long to include here. But we must pay tribute to the far-seeing generosity of Dr. Jacobs, whose boundless faith and indefatigable efforts have guided the plan far along the path toward completion. The first crypt is now being filled; it is hoped that others will follow. To Dr. Jacobs goes the heartfelt thanks of all thinking people for providing the basis for an altruistic and unselfish gift to the world of 6000 years hence.—*A. P. P.*

AN AIR-MINDED FIRST LINE OF DEFENSE

Naval Air Force Efforts Directed Toward One Main Objective—to Increase the Efficiency and Striking Power of Whole Fleet

By JONAS H. INGRAM
Captain, United States Navy



THE startling events of the past few weeks, preceded by the militant actions of great nations for the past two years, offer a tragic demonstration of how quickly an unprepared country may be subjected to the will of an unscrupulous outside force in total disregard of written treaties, law, morality or justice.

Recently, the President of the United States addressed a message to the Congress recommending authorization for an increase of the U. S. Navy of approximately 20 percent. This proposed naval expansion is to provide adequate national security and to aid in insuring peace. Following this important declaration by the Chief Executive, the Secretary of State enunciated the foreign policy of the United States, but added that "no policy would prove more disastrous than for an important nation to fail to arm adequately when international lawlessness is on the rampage."

The catastrophic developments in international relations have aroused the people of this country from an apparent apathy in regard to our own defense to such an extent that there is more active interest being taken in our Navy than has been shown in a decade.

This reborn public interest has aroused open discussion of the fundamental principles of security as applicable to the Navy. Many opinions have been expressed by radio commentators, pacifist organizations, and other well-meaning but poorly informed sources. The result has been that the citizen who wants to know the facts and who is entitled to the information is more or less bewildered as to what we have and what we need, not only to provide security, but to maintain this country in a peaceful and non-aggressive status.

The Naval Affairs Committee of the House of Representatives have held extensive and illuminating hearings on the Naval Expansion Bill. The testimony is lengthy but if every citizen had the time to read it, he would be convinced that the professional naval officer knew much more of the subject matter than expressed by most others appearing before the committee. Furthermore, the evidence is conclusive that weight should be given to the opinions of these men who have consecrated their lives to the study of war at sea and who are much better equipped to settle such controversial subjects as "plane versus surface ship."

Contrary to general opinion, the Navy is air-minded to the *n*th degree. A modern naval officer not air-minded would be just as antiquated as the old veteran familiar only with square riggers and muzzle loading carronades. The naval officer has, indeed, been a pioneer in the development of American aviation; and there are several naval fliers on the active list today who received their first training from the Wright brothers and Glen Curtiss. On the active list today are officers and men who made the first Navy transatlantic flight soon after the World War.

THE naval air force has expanded quickly and has contributed much to the development of aviation in general. The naval aviator has co-operated with the civilian designer in the progressive developments of planes, engines, control instruments and safety devices while working in his own field in designing catapults and plane carriers and using ingenuity to devise tactics to accommodate the various types of naval planes.

When aviation progressed to the point that a plane could be successfully catapulted from a man-of-war, could be picked up in a seaway, refueled and sent off again, the Navy knew it had something worth while. This is a weapon of inestimable value.

A splendid training school for naval aviators was established at Pensacola, Florida. Ground aviation was incorporated in the curriculum at the Naval Academy, where midshipmen were given instruction in ground aviation, gunnery, aerial navigation, and communications.

Each graduating class is subject to a rigid physical examination for aviation. After two years at sea, a certain percentage of those found physically qualified are selected for flight training. After an intensive year's training course, those successful in passing all the tests earn the coveted "wings" of the naval aviator. Many older officers of all grades were given the same course of training. The net result is that the Naval Air Force is manned by *regular naval officers.* There has been an exception to this re-

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

cently when some college men have been taken in as cadet aviators, given flight training, and now have flight duty only.

An accompanying table indicates the percentage of regular line naval officers who are qualified first class aviators, their paramount duty being aviation. These statistics are enlightening and may be surprising. At any rate, they go a long way to substantiate the statement that the Navy is air-minded; indeed, they show that great numbers in the regular establishment are actually engaged in duty connected with the aviation arm of the fleet.

THE non-flying naval officer has watched the progress made by naval aviation. The Commander-in-Chief of the Fleet, his subordinate Commanders and Captains of individual ships *know* what service the Air Force can give them. The gunnery people on board ship know what valuable assistance the Air Force can provide in the control of gun fire. The Air Force is valuable in so many fields of endeavor that it is a component part of the fleet; it works in close conjunction with the fleet but, on the other hand, is also dependent on the fleet.

As a consequence, the Navy has the same confidence in the air component as in the other categories that go to make up the fleet.

The Air Force in the fleet is commanded by a flying Admiral. The big plane carriers are commanded by flying Captains who are also regular naval officers. A recent Commander-in-Chief of the United States Fleet has been a flight officer and the present Commander-in-Chief of the United States Asiatic Fleet, Admiral Harry F. Yarnell, is a qualified naval aviator and has been Commander of the United States Fleet Air Force.

A fleet to be efficient must be in material readiness with a trained personnel ready to fight on 12 hours' notice or less. In view of the fact that it takes from two to four years to build a large surface ship and from one to two years to build up the air force to the strength necessary, we cannot hope to have the desired naval effectiveness prior to 1942, though the psychological effect of this building program on any probable foe would certainly act as a deterrent to any contemplated hostile activity against this country.

Experience has proved that airplanes are not capable of operating independently over vast areas of the open sea. For this reason, no fleet operating at sea, at great distances from land, can be assured of the vital assistance afforded by airplanes unless it provides within the fleet itself the means of basing, maintaining, and efficiently operating such airplanes.

Every combatant ship of our fleet, except destroyers and submarines, carries its complement of airplanes, varying in numbers from 78 operating aircraft on the carriers to two to four on other ships. Constant training has developed tactics for harmonious and efficient co-operation between air, surface, and sub-surface units to a point where aircraft in fleet operations are as much an indispensable part of the whole as any other type of ships. Airplanes have not supplanted ships, but they have added enormously to the power and efficiency of the fleet as a whole.

Photographs U. S. Navy, Official

Aircraft are as much a part of the fleet as are surface vessels

There has been presented to the public (but not by the Navy) the controversial issue of the superiority of the plane over the surface ship. This same discussion has been aired before by the supporters of submarines and torpedo boats when these innovations came into effective being. The answer is the same in all three cases. A lone battleship would be at a serious disadvantage if attacked in force under ideal conditions by any one of these three types of units.

A lone battleship or lone battle line attacked by a number of submarines would be at a disadvantage. Some of the pre-war ships might have been sunk by one torpedo hit. To obviate this, the construction of ships was complicated by extra compartmentation and blisters so that a ship might receive several torpedo hits and still be able to maneuver and deliver effective fire. In addition to this, the destroyer screen was developed so that battleships might cruise in submarine waters with no grave danger.

Aviation in

		No.	%
1. Total number of line officers in the regular Navy, January 1, 1938		6327	100
2. Naval aviators—1st line active duty			
Admirals	3		
Captains	15		
Commanders	52		
Lt. Commanders	162		
Lieutenants	441		
Lieutenants (jg)	337		
Ensigns	1		
Warrant Officers	8		
		1019	15.9
3. Line officers having had benefit of ground aviation or flight training but not in naval aviation at present		4531	71
4. Line officers not regular aviators who have flown in naval planes in unofficial or semi-official capacity (estimated)			95
5. Estimated percentage of line officers who feel			

A lone battleship at anchor, if attacked by a number of planes, would undoubtedly be hit. New horizontal protective and splinter decks would withstand many direct hits, and her blisters and compartmentation would protect against the near hits. The battleship's heavy anti-aircraft battery would certainly do damage but could probably not beat off a heavy air attack.

It is, however, hardly conceivable that a lone battleship or lone battle line would ever be allowed to be subjected to such an attack unsupported. The defense against an enemy air raid is, first,

our own air force. If we are strong enough in the air they won't break through. If we are equal to the enemy, it is fair to assume that in the ensuing dog fight few enemy planes will break through and those that do will meet a warm reception from the anti-aircraft batteries of the heavy screening force as well as of the battle line itself.

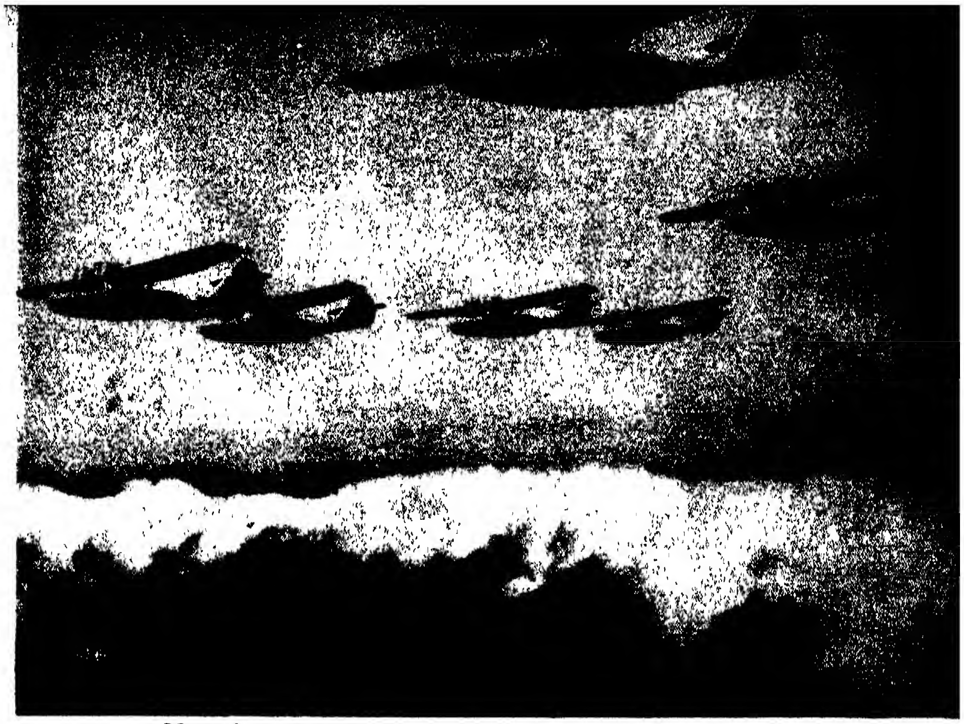
Bombing a moving ship is much more difficult than bombing a town or other area on shore. Actual bombing records under target practice conditions, where no opposition is involved and conditions are usually ideal, show that the accuracy of bombing against a ship target, small in area and free to maneuver at high speed, is much less than with a target on shore and naturally decreases

the Navy

		No.	*%*
that naval aviation is a great asset to our fleet and who are air-minded to a high degree			99+
6. Number of enlisted men qualified pilots		396	
7. All other enlisted men in aeronautical organization		18,796	
8. *Flying cadets:*			
In fleet	406		
Pensacola	341		
Total		747	
9. *Training:*			
Naval aviators	97		
Naval aviator pilots	140		
Cadets	341		
Total		578	
10. Number of serviceable planes in commission October 31, 1937		1134	
Number of planes on order		652	
Total planes		1786	

with the altitude of the bombing planes. The higher they fly, the poorer their accuracy. The lower they fly, the greater their exposure to anti-aircraft fire.

When the fleet is disposed in a cruising formation or for battle the number of highly efficient anti-aircraft guns that could be brought to bear on an enemy air raid literally amounts to hundreds. Actually there are more than 800 five- and three-inch anti-aircraft guns in the fleet. This battery, which is probably the largest in the world, is capable of putting into the air more than 8000 rounds of shrapnel a minute. Surely enough to make the overhead spaces very dangerous for any type of plane, bumpy enough to jar the most intrepid ace. Their effectiveness cannot be discounted; they are capable of placing a barrage at a greater height than 20,000 feet and they are effective for direct hits against a fast moving target at from 12,000 to 15,000



More than simply "eyes of the fleet"; aircraft are "hornets" as well

feet. They can put out a terrific fire against dive bombing.

There are, therefore, three main defenses against aircraft raids on our own fleet. The first and most effective consists of breaking up raids by our own air striking force. The second is concentrated anti-aircraft fire from the entire fleet. The third resides in the armored deck protection, compartmentation, blisters and maneuverability of ships.

Under present-day conditions it may be reasonably assumed that no foreign fleet could cross either great ocean and arrive with sufficient air strength to wrest control of the air from our *proposed fleet.* And with control of the air in the area of operations, our fleet should be in a position to effect a sudden termination of the campaign.

In this connection, it should be noted that the advent of the airplane has changed both defensive and offensive tactics. For example, if the Navy is called upon to protect a section of our coast the first line of defense must be projected seaward 500 to 1000 miles or more to prevent effective launching of an enemy air attack that far from the coast or to prevent the enemy from establishing a shore base from which they could initiate an air raid.

The component parts of a well-balanced fleet are: (1) The battle line, consisting of heavily gunned and armored ships, the backbone of the fleet—able to take and give heavy punishment, the loci of all offensive and defensive operations; (2) The air force, consisting of the plane carriers, carrier planes, ship's planes, and the tender shore-based patrol planes; (3) The cruiser force; (4) The destroyer force; (5) The mine force, minelayers, and sweepers; (6) The submarine force; (7) The fleet auxiliaries —fuel ships, supply ships, repair ships, hospital ships, and others.

If the veil of secrecy could, for reasons of national security, be raised from this fleet so that every one could see the practical tests demonstrated by a great naval maneuver at sea, the points made in this article would be apparent. Any doubt as to effectiveness of the various elements of the fleet would be removed. There would be no question as to the need for all the elements that go to make up this fleet. Respect for the battleship would be re-established. Admiration for the air force would be expressed. The casual observer would agree with the naval officer that our Naval Air Force has no peer in the world for its size— and its size will soon not suffer by comparison.

THE Navy makes no attempt to evaluate the relative effectiveness of each type component of the fleet. They all have certain limitations. The statement that any type is superior to any other type is misleading.

No one knows better than the Navy, the uses, potency and desirability of a powerful air arm. Our fleet without the air arm would not be a fleet, nor would it be a fleet with only an air arm.

The Navy will, therefore, do all in its power to maintain the proper proportion of aircraft to keep our fleet balanced. Our people may rest assured that aviation in the Navy will receive enthusiastic, intelligent, and sympathetic support that will produce an even greater and more effective air arm.

What concerns the Navy most is that we may have the ingenuity, initiative, and sufficient appropriations to keep our fleet second to none, for it is the unanimous opinion of your trained naval officer that such a fleet will not only provide this country national security but it will be the means of maintaining for us the everlasting peace which we so desire.

The Coolest Stars

Results of the Recent Successful Search for Faint Exceptionally Red and Infra-red Dwarf Stars . . . How The Temperatures of Such Stars are Ascertained

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington.

WE considered last month the question of the Sun's temperature—finding, perhaps to our surprise, how many ways there were of defining it, and of getting some sort of average value for the different layers of hotter or colder gases from which the light comes to us. The question, How hot is a given star? is clearly an even more important one for astronomers; but, unfortunately, we have a much smaller number of ways of answering it. Except in a very few cases, we cannot use the reliable method depending upon the total amount of heat radiated per square mile of the surface, for the heat is too small to measure, except for the brightest stars, and the diameter can be observed for only a very few. The last difficulty prevents us, too, from making the alternative calculation depending on the amount of light of a given color which is emitted per square mile. We have to depend upon the more complicated conception of the color-temperature. It is not hard to measure the color of a star's light—that is, its relative brightness in any two known wavelengths; and it is very simple, theoretically, to calculate how hot a standard radiator would have to be to give out these kinds of light in the same proportion. The trouble is that the gaseous surfaces of the stars are unlikely to behave like a standard solid hot body. Even so, we appear to get good results, so far as we can test them, for most stars.

To save circumlocution, the writer will at this point—with due apologies—put in just a little algebra. It can be shown from the general law of radiation that, if a perfect radiator of radius R times the Sun's, and temperature T (on the usual Kelvin scale) were viewed as a star, at the standard distance of ten parsecs, and its stellar magnitude M measured in light of wavelength λ, the result would be $M = A + \frac{B}{\lambda T}$, where A is a constant depending on our zero-point of measurement, and B has the value 1.535×10^8, provided that λ is measured in Angstrom units as usual. (This is not an exact formula, and must be corrected for very hot stars—with which, however, we are not here concerned.) Introducing the known value of M and the approximate temperature 6000° for the Sun, it is found that for visual observations, for which the effective wavelength is a little less than 5400A, $M_V = \frac{28500}{T} - 5 \log R + 0.08$. For photographic observations (λ4300) $M_P = \frac{35700}{T} - 5 \log R - 0.56$. The difference between the visual and photographic brightness, called the color-index, is $M_P - M_V = \frac{7200}{T} - 0.64$, or, re-written, $T = \frac{7200}{M_P - M_V + 0.64}$.

The calculation of the temperature at which a standard radiator would give out light of the observed color of the star is thus made very simple. For a star like Vega, for example (Class A), $M_P = M_V$, and $T = 11{,}200°$ (closely enough).

The temperatures calculated in this way range from over 20,000° for the blue-white stars of Class B to about 3000° for the red stars of Class M. Evidence that this temperature scale is not seriously wrong is afforded by the few stars for which we know the diameters, and can use the other methods, and also by the various degrees of excitation of the atoms (as discussed last month) which are shown in the spectra.

THERE are some cases, however, in which the results are obviously wrong. The very red stars of Class N give out almost no ultra-violet light. If one tries to calculate the temperature by comparing their visual brightness, in the green, with that in the ultra-violet, the results come out something like 1000°—an impossibly low value, since the spectra show that great quantities of carbon vapor are present in the stars' atmospheres. Wildt has pointed out that these atmospheres, full of molecules of various compounds, should absorb ultra-violet light very strongly, while the corresponding effect in the green and yellow, though present, is much weaker. Since stellar magnitudes increase numerically for faint objects, these atmospheric effects increase M for both kinds of light, but much more for the ultra-violet than for the green, and it follows from our equation that the calculated temperature will be too low.

For the commoner type of red stars (Class M) the absorption bands of titanium oxide are very strong in the green and yellow, and not prominent in the violet, so that the effect works the other way, and the calculated temperatures are too high.

It is obviously desirable to get at least partially clear of these difficulties—and this may be attempted by measuring the magnitudes of the stars with other colors of light. It would be of little use to go into the ultra-violet—the Earth's atmosphere absorbs more, and so do the atmospheres of a large proportion of the stars. But it is worth while to go the other way, into the red and infra-red.

Modern photographic plates are sensitive to regions far beyond anything that the eye can see, and some of the newer ones are fast enough to give good images of the stars with a reasonable exposure time.

Successful work has been done in this way by several observers—notably by Dr. Hetzler at the Yerkes Observatory. With suitable plates and color filters, he has secured numerous photographs with light of average effective wavelength 8500A, and a smaller number at 9300A, and has worked out and tested photometric methods for determining "infra-red" magnitudes of the stars. The zero-point from which these magnitudes are measured was adjusted so that they agreed with the ordinary visual magnitudes for a star of spectral class A0 (for which the photographic magnitudes are also adjusted to agree).

If we let $\lambda = 8500$ in our first equation, and adjust the constant A so that the results agree with the other magnitude systems for $T = 11{,}200°$, we find by very simple algebra

$$M_I = \frac{18100}{T} - 5 \log R + 1.01.$$

The difference between the visual and the infra-red magnitude, which Hetzler calls the infra-red index, comes out $M_V - M_I = \frac{10400}{T} - 0.93$ or, solving for T, $T = \frac{10400}{M_V - M_I + 0.93}$. Similarly, from the

photographic and infra-red magnitudes, we find $T = \frac{17600}{M_p - M_i + 1.57}$.

We have now three ways of getting the temperature of a star—but not three independent ways (for the third equation may be derived from the other two by "clearing of fractions" and adding). For a star which radiated like a standard "black body" the three results should come out the same, barring the small influence of errors of observation. If the results from good sets of magnitude observations do not agree, it is clear that the star does not radiate like a black body. We may then be able to apply whatever other knowledge we have to decide which of the three values is most nearly right. For example, for an ordinary giant star of Class K, $M_p - M_v$ is about 1.0 and $M_v - M_i$ about 1.5, whence $M_p - M_i = 2.5$. Applying our equations, we get temperatures of 4390°, 4290° and 4340°, respectively. The rather outrageous simplification which substitutes a hypothetical uniform solid surface for the combined effect of the hotter and cooler layers of gas at different depths in the star's atmosphere works remarkably well in this case.

FOR the redder giants, of Class M, $M_p - M_v$ averages about 1.8, $M_v - M_i$, 3.0, and hence $M_p - M_i$, 4.8. The corresponding temperatures are 2950°, 2650° and 2750°. The agreement is not so good; but we know that for these stars the band absorption makes M_v too faint (numerically, too big) without affecting either of the others as seriously. Hence the first of the calculated temperatures should come out too high, the second too low, and the last be little affected.

These are, however, commonplace objects. The most interesting feature of Dr. Hetzler's work must have been the successful search for exceptionally red stars. With the Yerkes 24-inch reflector, and the 10-inch Bruce camera, (which has a good, sharp, focus for the infra-red) stars are occasionally found which stand out on the infra-red plates, but are almost invisible on plates taken with yellow light, and often quite invisible on ordinary plates, sensitive only to the blue and violet.

A good many stars have thus been found which have infra-red indices ($M_v - M_i$) of 6^m or more, and a few values run up to 9^m or even 10^m. A star which is 10,000 times brighter in infra-red light than to the eye must be a remarkable object. Our equation would give a temperature of 1500° for an index of 6^m, 1170° for 8^m, and only 950° for 10^m. It is probable that in these extreme cases the visible light is greatly cut down by opacity in the star's atmosphere, which has less effect in the infra-red. But, making all allowance for this, it is clear that this infra-red survey has introduced us to cooler stars than had ever been known before.

Many of these very red stars are previously known variables, mostly of long period—which was to be anticipated

©Harris and Ewing

At various times regular readers of Professor Russell's monthly articles on astronomy have requested the editors to publish his photograph. This is now done without his knowledge, since he is on the high seas at the time of insertion

since it was already known, from measurements of the total heat radiation, that typical stars of this sort had temperatures of the order of 2000°, and often less at minimum. The variation in the infra-red is much smaller than in visible light. This is to be attributed partly to the direct effects of temperature—which, as our equations show, should produce a range 60 percent greater in the visible than in the infra-red, and partly to increasing band absorption in the visual region as the star grows cooler. A considerable number of the very red stars discovered in the new survey have already been found to be variable, and more will probably turn out in future to be so.

The newly discovered "infra-red" stars all have small proper motions—as is indicated by comparison of recent photographs with others taken many years ago (on ordinary plates). This indicates that, like the long-period variables, they are giant stars much brighter than the Sun visually, and still brighter in infra-red light. It is likely to be a good while before accurate determinations of proper motion, and hence of distance and real brightness, will be practicable; but there can be no reasonable doubt that they must be bodies of very large size. One more look at our equations shows that, if differences of temperature alone were at work, the change in actual brightness of a star, even in the infra-red as its temperature decreased, would be almost twice that in the infra-red index. A liberal allowance for selective absorption still leaves us with the conclusion that these stars give out much less light per square mile than any others. Hence it is probable that they are of enormous dimensions—with diameters very likely exceeding that of the Earth's orbit.

HETZLER notes that, in a careful survey covering about 300° square degrees (1/14 of the whole heavens), no infra-red indices greater than ten magnitudes have been found. He suggests that this fact may have some astrophysical significance. One possible explanation is this: It is probable that these very large indices arise in considerable part from obscuration of the visual light by bands in the spectrum, as the stars grow cooler. If, near some limiting temperature, these bands reach a maximum of intensity, cooling down to this point would produce a rapid change in the index, as the bands increased, and further cooling would have a much smaller effect.

It would be of great interest to observe the spectra of some of these very cool stars. Observations of the red end, with great reflectors, should easily be possible; but it is doubtful whether even the greatest telescopes can collect enough light to make a photograph of the visual part of the spectrum possible.

In addition to these giant stars, Dr. Hetzler's list includes a few red dwarfs—specially observed. Barnard's star, for which $M_v = 13.7$ corresponding to a luminosity 1/3500 of the Sun's, has $M_v - M_i = 3^m.0$ which would indicate a temperature of 2650°. With this value we may go back to our equations and deduce $\log R = -0.58$, corresponding to a radius one quarter of the Sun's.

For the faintest known star, Wolf 359, $M_p = 18$, $M_v = 16.5$, and $M_i = 11.5$. The temperature comes out 3300° from $M_p - M_v$, 1750° from $M_v - M_i$ and 2200° from $M_p - M_i$. The last value is probably the best. It gives $\log R = -0.35$, and makes the radius 45 percent of the Sun's.

Neither of these values is likely to be very accurate, but they are enough to show that these extreme dwarf stars are so faint, not because they are very small, but because they are cool.

Modern Plant 'Wizardry'

Breeders Maintain and Improve Plant Heritage . . . No Magic; Persistence and Patience Get Results . . . Art and Science of Great Economic Value

By KEITH C. BARRONS

WHILE riding on a train not long ago I happened to engage in a conversation with an electrical engineer. After discussing a number of subjects, he casually asked the nature of my business. When I told him I was a plant breeder he replied: "Oh yes, you make crosses between different plants and that sort of thing."

Yes, we do make crosses between different plants, but "that sort of thing," as expressed by the engineer, represents the remainder of our work. It signifies the great mystery concerning the art and the science of plant breeding existing in the minds of most individuals. Exactly what does the breeder aim to do and how does he accomplish his purpose? What is plant breeding, anyway? These questions in one form or another have been asked of every plantsman time and again.

Plant breeding involves more than the cross-fertilization of different individuals, or hybridization, as it is technically known. Indeed, it involves more than the so-called creation of valuable new varieties. Any effort on the part of man to maintain or improve the heritage of plants is rightly classed as plant breeding. Note these two phases of the breeder's work: to maintain and to improve the heritage of plants. The maintenance of varieties at their original hereditary level is not as spectacular as the creation of new strains, but its importance is unsurpassed. Without careful propagation and seed-growing methods, and without the continual elimination of off-type plants known as rogues, the best varieties would soon "run out" and lose much of their usefulness.

Although cultivated plants vary in size from radishes to giant forest trees, in botanical relationship from mushrooms to sunflowers, and in utility from wheat to orchids, the same principles of genetics govern the transmission of hereditable characters from parents to offspring. There are also fundamentals of breeding practice applicable to all plants and certain other basic methods which may be used with plants within a certain group. If one understands these underlying principles of breeding, which are based on a sound knowledge of genetics and the various branches of botanical science, he has only to "know his plants" in order to be an efficient breeder. By knowing his plants, I mean that he must first of all be familiar with the types and varieties within the species with which he is working. It is imperative that he understand the morphology and physiology of the flowering parts of his plants and have access to the existing literature on the genetics of the particular species involved. Perhaps most important of all, he must know what improvements would be desirable—in short, what to save and what to throw out in breeding operations.

I once had a mongrel dog that, for my purpose at least, was better than any pedigreed member of a highly publicized breed. But he grew old, and being of an extremely complex genetic make-up it was useless even to attempt to breed another individual with the same temperament and physical characteristics. Finally, the old mongrel died, and his kind was lost forever. Even with so-called pure-bred strains of animals, no two individuals are exactly alike, and we must take our chances on transmitting the desirable traits of individuals to their offspring. But with many plants it is different, for, in addition to reproduction by seed, the practice of asexual, or vegetative, propagation makes it possible to perpetuate indefinitely the desirable individuals of most woody and many herbaceous species. Fruits and nuts propagated by grafting, potatoes grown from tubers, flowers increased from bulbs, and countless other ornamental plants grown from stem cuttings are examples of plants increased by vegetative means.

Snapdragon breeding. Plants with desired characteristics are fully caged to insure their self-pollination

IF I could have amputated my old mongrel's leg and from it grown another dog identical with the first, except for minor variations due to differences in environment, my act would have been comparable with these vegetative propagation methods. No sexual process is involved; so, regardless of what kind of a mongrel a plant may be, it can be increased year after year with no perceptible hereditary change with the exception of relatively rare bud sports or mutations. The winesap apple, for example, originated as an off-type tree grown from seed (a seedling, in the terms of the breeder) over two centuries ago. Like my mongrel dog, this seedling was superior to other members of its species, and before it died someone grafted its buds on other apple root stocks. Thus each tree in the vast winesap orchards today is a vegetative descendant of the original. In fact, genetically speaking, each tree is a part of that first winesap seedling.

A seed, like an embryonic an-

mal, is the result of the union of sperm and egg cells. When the winesap apple is asexually reproduced, hereditary variation is no more likely to occur than at any other period in the growth of the plant, but if one plants seed of this same apple a wide variation in the seedlings will result. This variation is due not only to the possibility of the seed having as the male parent a variety other than winesap, but chiefly to the segregation or sorting out of the genes that control heredity. These tiny entities, present in every cell, account for both the likenesses and differences of parents and offspring. With plants, as with animals, one has to expect bad as well as good combinations of genes.

The story is told of a beautiful English lady who was a bit over-optimistic on the matter of gene combinations. She addressed a letter to George Bernard Shaw as follows: "Dear Mr. Shaw: You are by far the most intellectual man in the entire empire and I am considered the most beautiful woman. Would it not be fine if we were married? Our children would have your intelligence and my beauty."

A few days later she received a curt reply signed G. B. S., "Madam: What a calamity it would be if they had your brains and my figure."

When plants are grown from seed, their reproduction is comparable with that in animals except for the fact that, with few exceptions, they may be self-fertilized. Most individual plants possess both male and female sex organs which makes it possible to inbreed much more closely than in animals. In the case of many plants, self-fertilization is the rule rather than the exception, while others are naturally cross-pollinated.

It is well to emphasize the fact that plants grown from seed are often divided into two groups. The first group includes those that are naturally self-fertilized, such as beans, tomatoes, and wheat. Because of continual selfing, generation after generation, plants in this group are inbred to the extent that they are genetically pure, or homozygous in the terms of the breeder. As a rule, seed saved from individual plants will breed true for all inherited characteristics, and there will be no loss of vigor if new strains are started from individual plant selections. When a breeder is working with these naturally selfed plants, he does not have to isolate a variety being grown for seed purposes from others of the same species. Furthermore, individual plant selections do not have to be bagged or caged as neither wind nor insects will carry the pollen to any appreciable extent.

The second group includes those plants that are naturally cross-pollinated. Corn is a fine example, as its pollen is blown about by the slightest movement of air. When working with these naturally crossed plants, the breeder must control pollination by some form of isolation either of the entire plant or individual flowers. When he self-pollinates to secure a uniform inbred strain, vigor is often lost just as when brother and sister matings are made with dogs or farm animals. Lost vigor then has to be regained by crossing back with other inbred lines which are similar to the first with respect to those desirable characteristics the breeder wishes to have in his new variety. Due to their habit of cross-pollination, it is difficult to maintain absolutely pure strains of plants in this second group. There is usually some hereditary variation from plant to plant; therefore improvements can often be made merely by selection of individuals possessing the most desirable characteristics. Because of their great uniformity, selection alone is not as valuable a technique with varieties that are normally self-fertilized.

1

2

3

4

5

Steps in cross-pollinating a tomato flower. Cluster is trimmed (1) to leave chosen flower. Its pollen sacs are removed (2). Then pollen is secured from a male parent (3) and used to pollinate the chosen female (4); after which it is labeled and covered (5) with glassine bag

PLANT breeding is not unlike natural evolution. As expounded by Charles Darwin, there is a constant struggle for existence among all forms of life. Most individuals "can't take it," and only the fittest survive. This natural selection of the fittest has been called the guiding factor in evolution. When breeding plants, man largely eliminates the struggle for existence by proper cultural practices; however, natural selection remains as a guiding factor and is extended by man's selection of individuals and types that fit his needs. All in all, the plant has as tough a time surviving in the hands of the breeder as in nature, for we are ruthless when discarding individuals and lines. The difficult part of breeding plants is not in securing new and different things but in choosing the best and eliminating the mediocre and inferior. From a few crosses anyone can obtain variation in succeeding generations, but which of the variants are desirable? Which individuals should be saved and which discarded?

Selection of individuals is the basis of all plant-breeding work. Hybridization is but a means of increasing variation, a method of producing new combinations of characters. Hybridization must be followed by selection to be of any value. Progeny tests must be grown

A corn test plot where very important variety-testing is conducted

from plant selections of the seed-reproduced species in order to determine whether or not they will breed true. The establishment of true-breeding lines is far from the final step, as they must be thoroughly tested in order to determine their worth. For example, a tomato breeder may save seed from 100 plants that appear outstanding in a hybrid population. The following year 100 rows are grown, each from a different plant selection. Perhaps 20 of these lines appear to be breeding true; that is, each plant in the row seems to possess the same hereditable characteristics. Eight of these twenty lines appear outstanding on the basis of general appearance, so the other twelve are discarded. A breeder cannot introduce eight new varieties to tomato growers all at the same time. Perhaps the differences between them are very slight. Which will he save as the progenitor of a new desirable tomato variety? Answering such questions is one of the most difficult tasks of the breeder. Promising new strains must undergo rigorous tests for many things such as yield, quality, and resistance to disease before their value can be established. They must be compared in great detail with existing varieties in order to determine whether they would really make a worth-while addition to an already lengthy list.

WHEN testing plants for resistance to diseases, breeders have the aid of plant pathologists who have learned how to produce artificial epidemics. Thus the plants are subjected to natural selection of the most rigorous sort. Natural selection is a valuable aid to the breeder in developing varieties resistant to winter injury and drought, but again he sometimes out-does nature by exposing plants to artificial cold and drying winds to determine their true reactions.

In nature, plants did not evolve from lower to higher forms because of the factors of natural hybridization and selection alone. The genes controlling the development of distinct new hereditary characteristics did not exist at the bottom of the evolutionary ladder. They were formed by sudden changes called mutations from one kind of gene to another. Thus, step by step, new plants arose by successive mutations, or sports, as they are often called. It is the continual occurrence of such mutations that makes it possible for breeders to create plant varieties possessing characteristics entirely unknown before. The new characters made possible by mutations are by no means all desirable. For every mutation that results in a valuable new

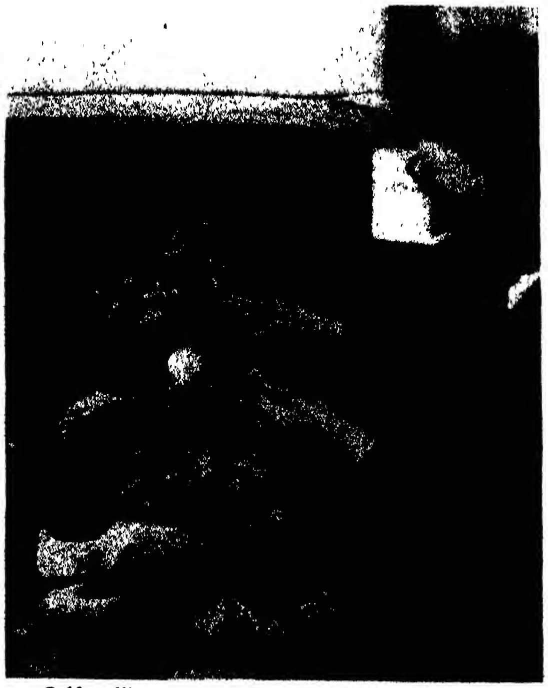
Insects cannot further pollinate this hand-pollinated squash blossom

variety there are hundreds that cause a step down the evolutionary ladder, a reversion toward an ancestral type. Still others produce freaks or weaklings of no value other than scientific interest.

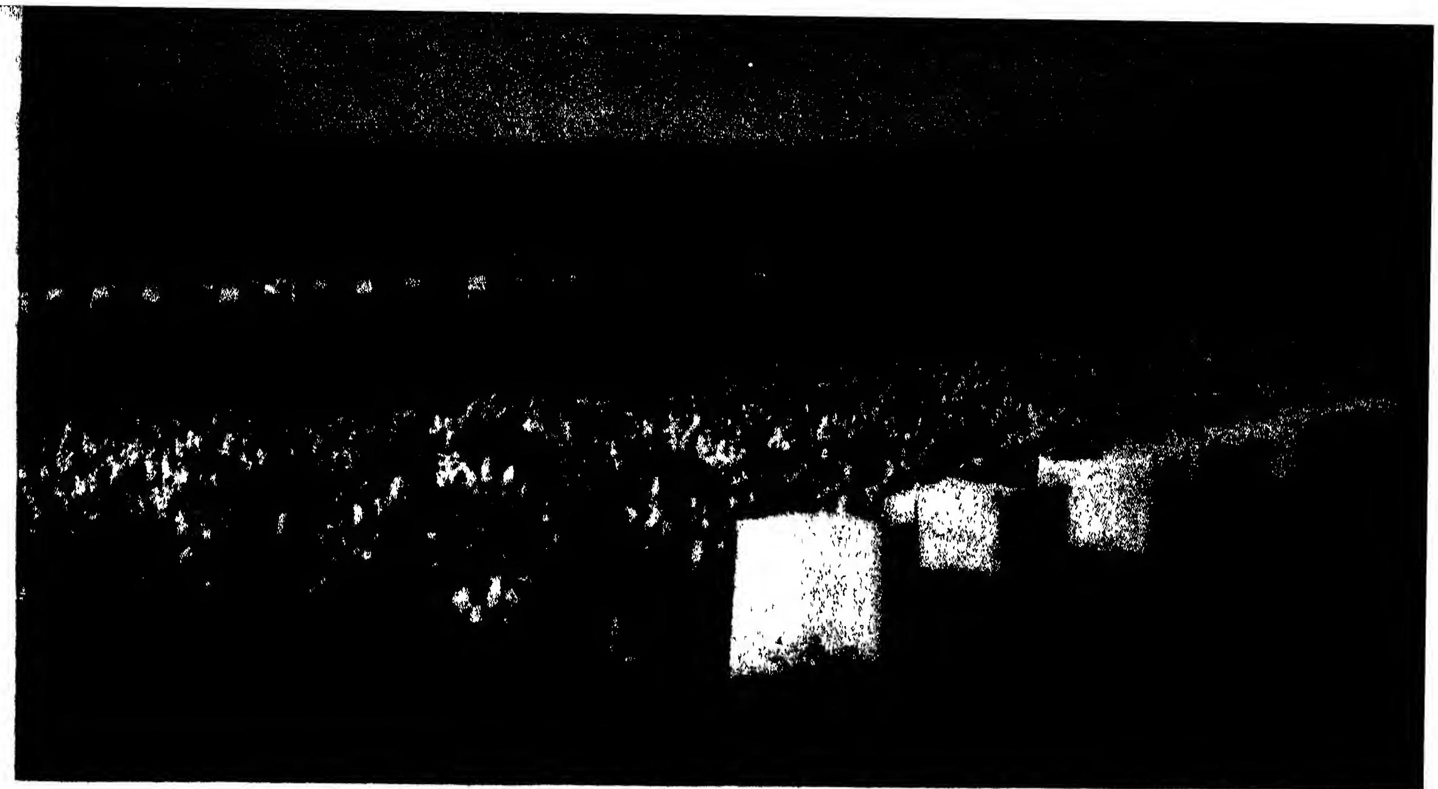
So-called "running-out" of varieties may be due to disease in many plants such as those propagated by cuttings, bulbs, and other vegetative means. In such cases, a systemic disease is carried from plant to plant in the vegetative part used for propagation. In seed-grown plants, running-out is usually due to a change in heredity rather than to disease. It may be brought about as the result of mechanical mixtures of seed, natural crossing with other varieties, or mutations to undesirable forms. These are the three things seedsmen have to fight continually. The off-type plants or rogues due to mechanical mixtures may be reduced or eliminated by care in harvesting, storing, and planting. Rogues due to natural crossing may be prevented by isolating crops being grown for seed, but rogues due to undesirable mutations can be reduced to a minimum only by the constant selection of desirable plants as a starting point for future seed crops.

DURING the course of a conversation with an English literature professor not long ago the subject turned to the plight of the southern tenant farmer and the legislation designed to aid him. "Why don't these farmers get some mares and raise their own mules rather than buy them from out of the state?" the professor inquired. "I should think they could save a considerable sum that way." I explained that horses do not thrive in the lower South due chiefly to climatic factors, and that they require more care and attention than the average tenant farmer would give them. "But I am talking about mules, not horses," the professor protested. "Why don't they get mule mares and raise mules from them?" I concluded that Shakespeare and Chaucer had sadly neglected the biology of the mule and hurried the conversation along to another subject.

Like the first generation cross between the jack and the mare, which results in the sturdy and vigorous mule, many plants resulting from crosses between two individuals of unlike heritage are notable for their hybrid vigor. Some, like the mule, are sterile and, therefore, of no value in themselves unless they can be propagated by asexual means. Many vegetatively propagated plants owe their



Self-pollinating cabbage plant by hand. Afterwards a large hood will cover and protect it



A flower breeding "work-shop" that covers acres and in which flowers may grow under natural conditions of soil and weather. The many scattered cages enclose individual nasturtium plants which have been saved for breeding purposes

existence as worth-while varieties to the fact that they possess outstanding hybrid vigor which can be carried on indefinitely.

With seed-grown plants, hybrid vigor can be of commercial importance only when it is practical to make crosses on a large scale. This has been done in a minor way with such plants as the tomato and eggplant, both of which yield a relatively large number of seeds for each hand-pollination, but corn is the outstanding example of the utilization of first-generation crosses as commercial seed. Corn is very easily cross-pollinated on a large scale merely by the alternate planting of varieties which have been found to make good parents; that is, varieties which, when crossed, will produce a first generation that possesses considerable hybrid vigor as well as other desirable characteristics. The tassels are removed from all plants of the strain being used as the mother parent so there will be no self-pollination and all seed produced on these de-tasseled plants must be from cross-pollinations. This is the seed that is sold so widely today as hybrid corn. In addition to possessing exceptional vigor, hybrid corn is noted for its great uniformity. The parents used in producing such corn are usually inbred lines which have been found to transmit especially desirable characters and remarkable vigor to their offspring.

MODERN plant-breeding work as conducted by the state and federal experiment stations is not a "lone-wolf" affair. Men with diversified technical and scientific specialties often co-operate on one breeding problem. The improved variety which results cannot be called the production of one man, sometimes not even of one institution. For example, let us look at Thatcher wheat, a new variety from the Minnesota Agricultural Experiment Station which combines excellent milling and baking quality with high yield and remarkable resistance to the dreaded black-stem-rust disease. Thatcher is truly a monument to scientific co-operation. It is the product of years of cumulative effort on the part of specialists in the field of breeding, in plant pathology, and in cereal chemistry to produce a highly rust-resistant variety, the grain of which would make flour to suit the most exacting baker and the most fastidious housewife. The breeders did the hybridizing and selecting necessary to the production of a new variety, but working alone they could never have accomplished the results that have been realized. Milling and baking specialists made thousands of tests of grain from different strains the breeders had selected. From these small samples they ground flour and made loaves of bread so the breeder could be informed which of his selections would meet the millers' and bakers' requirements. The plant pathologist had to develop a method of creating an artificial epidemic of the rust disease in the breeding plots so the selections could be tested for resistance each year and not have to wait for a natural epidemic to come along. A grain variety must yield well or farmers will not grow it even if it does resist the rust which so often ruins their crop. Thousands of selections had to be tested for yield in various parts of the spring wheat belt. Dozens of wheat specialists co-operated in this routine testing. Samples of grain from small areas were weighed and yields in bushels per acre calculated from these figures. The particular cross which resulted in Thatcher was made in 1921, but the history of this variety goes back much further than that. Each of the parents of the Thatcher cross were hybrids themselves, one made between the varieties Marquis and Immulo, a durum wheat, in 1915, and the other between Kanred and Marquis in 1918. But the breeding of Thatcher really had its beginning long before these crosses were made. Back in 1907, following a great rust epidemic which swept over the spring wheat belt, the Minnesota Agricultural Experiment Station and the United States Department of Agriculture began a search for a wheat like Thatcher. Thus Thatcher is the result of 30 years of uninterrupted effort.

EVEN after the state and federal experimenters had passed final judgment on this new variety, and after millers in Minneapolis had said, "It's O.K." on the basis of car-lot grindings of flour, the job was not finished. The task of the agricultural extension people, the farm organizations, and the farm magazines had only begun. They had to tell the grower about Thatcher, tell him what it would not do in certain localities. It was their job to put Thatcher across to the farmer. It was up to the seedsmen to grow and distribute this new variety in the same pure form in which it was first released by the experimenters. Indeed, the successful plant breeder today must first of all be a good co-operator.

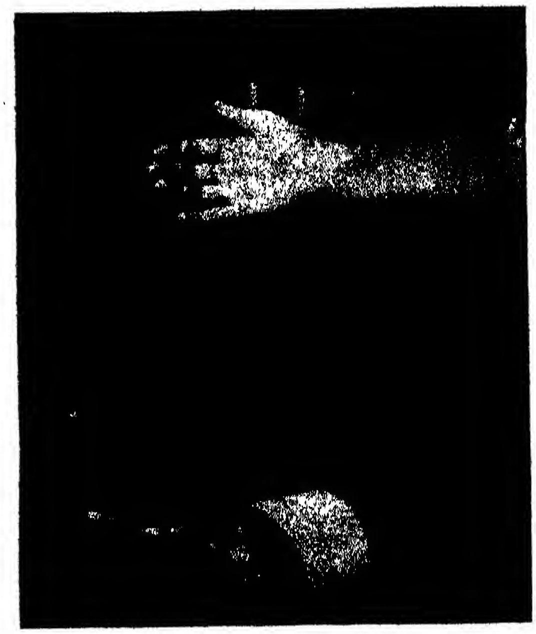
Photographs courtesy Agricultural Experiment Station, Auburn, Alabama; Associated Seed Growers, Inc.; Bodger Seeds, Ltd.; Ferry-Morse Seed Company.

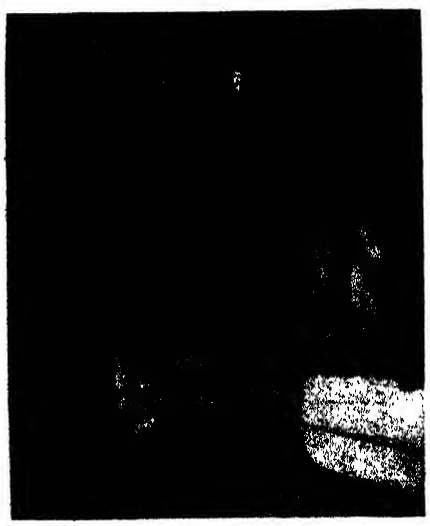
This is the second of two articles by Mr. Barrons. Readers interested in some of the actual results of plant breeders' work are referred to his former article "Streamlined Plants" in our March issue.—*The Editor.*

MIRACLES FROM MARBLES

By A. P. PECK

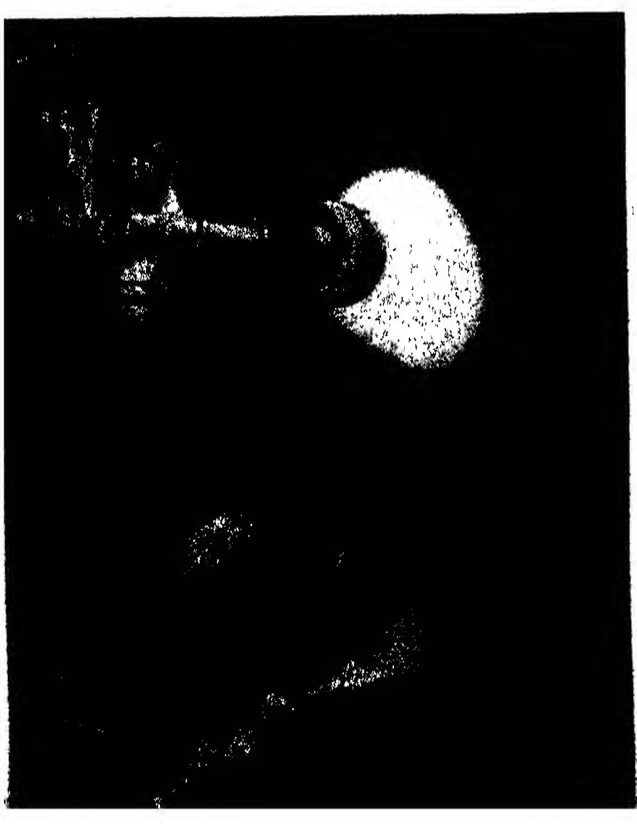
1 Fibrous glass, not new but now available for numerous applications through American ingenuity directed toward perfection of production, is made from "glassies", delight of schoolboys. Marbles are of convenient size and shape for feeding to melting tanks in both of the speed processes described here for making practical glass fiber





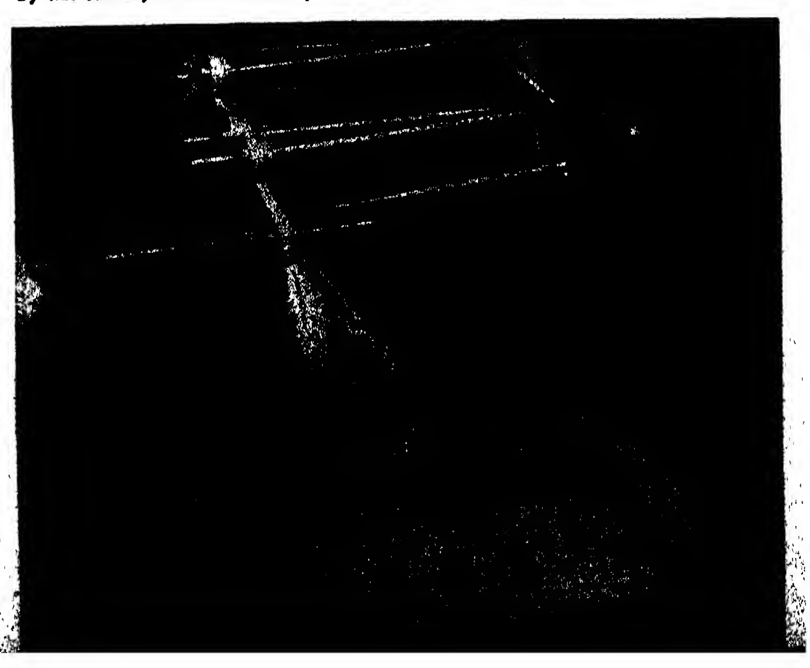
2 *Left center:* Glass marbles are fed automatically to melting tanks. In the "continuous filament" method of producing textile glass, the molten marbles flow downward from the tank through 102 holes in the pot. Thus a filament of glass emerges from each hole, to be grasped by the operator and attached as a bundle to a rapidly revolving steel drum or spool

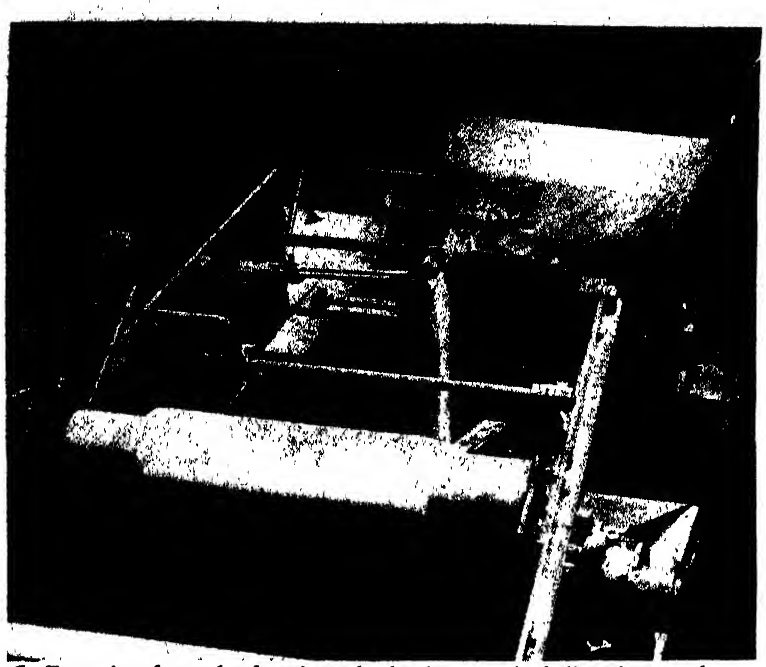
3 The combined filaments of glass, each only .0002 of an inch in diameter, are spooled *(right)* at a rate of a mile a minute. A ten-mile length of filament is assembled on each spool. A ¼-ounce glass marble can be drawn in filament form to a length of exactly 159.375 yards



4 In the "staple fiber" method of production, the melted marbles are blown by live steam under high pressure. The filaments, averaging 15 inches in length, pass through a gas flame *(left)* to dry out moisture caused by the steam, and to a conveyor

5 As the dried fibers are blown to the conveyor, they are picked up and drawn in a cobwebby mass over a series of forming wheels *(below)* which bunch the fibers into a loose strand known in the textile world as "sliver" (pronounced "sly-ver"). The photographs were taken while the machinery was in motion





6 Emerging from the forming wheels, the strand of sliver is wound up rapidly on spools. From this point on through the processing of fiber glass, most of the equipment used is identical with that employed in the processing of other textile fibers such as silk and cotton

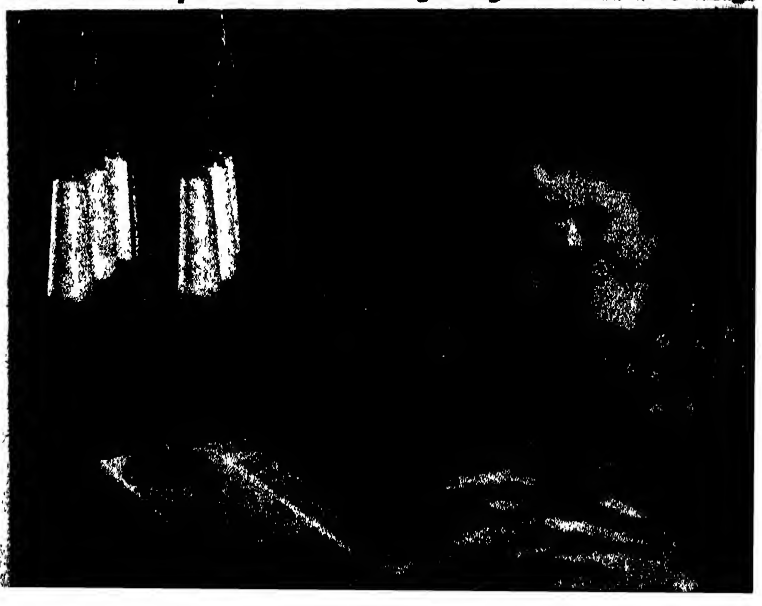
7 Whether continuous filament or staple fiber, the textile glass is now transferred to twisting equipment. Here two 102-filament strands are combined to form a single thread. Four strands so twisted are about the size of No. 50 cotton thread

8 One end of a broad loom on which glass textiles are woven is shown at the left. The roll of glass thread seen at the bottom of the photograph is wound to the desired size from spools such as are shown in illustration 7 (above, right)

9 *Right:* An over-all view of the broad loom. Glass thread from roll, right, passes toward left through shuttles and reeds. The fabricated cloth is on the roll at extreme lower left of picture

10 From marbles to cloth is a story of applied science opening a whole new field for an old-new product. The soft, satiny, pure-glass fabric shown below illustrates the possibilities. Present applications, however, are largely industrial rather than domestic; glass clothes, for example, are still in the future

11 *Below:* Sewing glass cloth with glass thread, making, for the first time in history, a completely inorganic fabric. Fiber glass, made by Owens-Illinois Glass Company and licensees, is fire, vermin and moisture proof, is finding wide use in industry for electrical and thermal insulation, in textile and unspun fibrous forms. Its light weight is an added advantage



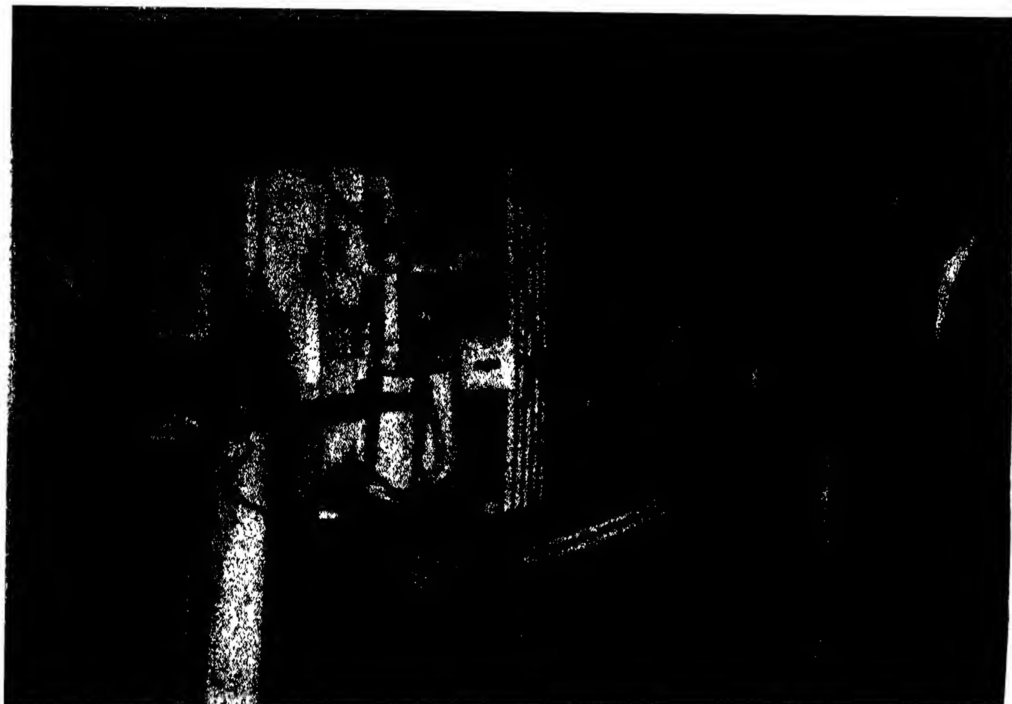


Photo Boston Herald

Dr. Edward C. Stevenson (at left) and Dr. Jabez C. Street, both of Harvard, the co-discoverers, with Anderson and Neddermeyer of California Tech, of the X-particle and the first to measure its weight; also the Harvard automatic cosmic-ray camera which photographs the tracks of incoming rays, including an occasional cosmic X-particle. Metal ring is part of a big magnet

And Now the X-Particle

Newest Applicant for Membership in the Atomic Family May Really be New or Merely an Old Friend in Disguise... Every Day Brings New Data in this Most Intriguing Puzzle of Current Atomic Physics

By JEAN HARRINGTON
Wellesley College

THE latest addition to the atomic family has been a somewhat unwelcome one. Like the sixth child in a household which has barely managed to struggle along with five, the new particle has forced many readjustments upon the physicists, who have been hard put to find a place for it, to know what to do with it, or even to give it a name.

Discoverers of this foundling of unknown origin were Carl David Anderson and Seth H. Neddermeyer of the California Institute of Technology. When Dr. Anderson tracked down the positron in 1932 and thereby won the Nobel Prize, he was looking for the tangible trace of a particle which had already been theoretically predicted. Not so with this latest interloper. It simply thrust itself into the field as the only possible solution to an otherwise baffling phenomenon.

The original clues came from experiments with cosmic rays, suggesting that the X-particle was in some way associated with those mysterious electric charges which stream in upon the earth from the depths of outermost space. When Anderson and Neddermeyer read a paper on cosmic radiation at the International Conference on Physics at London in 1934, they hinted, ever so slightly, that certain peculiar quirks in their data might need a new and startling explanation. But it was not until May, 1938, that, backed up by additional experiments, they came out flatly for a new particle.

In the meantime, Professors J. C. Street and E. C. Stevenson of Harvard had arrived independently at the same answer to the same problem; and their corroboration, appearing only two weeks after the Anderson-Neddermeyer pronouncement, launched the X-particle as the newest and most intriguing puzzle in atomic physics.

JUST as a commuter uses up energy in shoving his way through a subway crush, so does a cosmic ray particle in traversing the crowded atoms and molecules of any substance. In the atmosphere, for instance, the particle collides with a molecule of hydrogen here, glances off and bumps an oxygen molecule there, losing energy at each encounter, playing havoc with whatever it hits, and perhaps even breaking itself up in a final head-on collision.

For a long time scientists have been trying to find out at what average rate such a particle loses its energy. They have attacked the problem with high-powered mathematics to figure out what it should do in theory; and they have studied it in the laboratory to discover what it actually does do.

Around 1934, Bethe and Heitler, two of the great theorists of contemporary atomic physics, arrived at a solution which made both the experimenters and the arm-chair physicists happy. It's all very simple, they said. The rate at which a particle is losing its energy at any moment is, in fact, directly proportional to the total energy it has at that moment. Paradoxical as it sounds, it only means that if two particles start out with the same energy, they lose it at the same rate—that is, the same loss per centimeter of their paths through a substance. But if one particle is more energetic than the other, then its rate of loss is greater to begin with, though decreasing as the total energy decreases.

Anderson, Neddermeyer, Street, and Stevenson were among those who tried to test out this theory in the laboratory. Their procedure was to set up a cosmic ray "telescope"—an arrangement of counters and lead shields allowing only those rays with a given minimum energy and direction to pass through. At the far end of the telescope is a Wilson cloud chamber, that famous device which makes it possible to photograph the track of a charged particle as it whizzes through a gas.

The next step in the experiment was to place the cloud chamber between the poles of a strong electro-magnet. Under its influence, the electric charges are swerved from their straight line flight, and their tracks show up on the film as slender curves. Through the center of the chamber runs a known thickness of metal. This shield completely stops some of the tiny projectiles and slows up the rest. By comparing its curved track on both sides of the shield, the experimenters can tell how much energy a particle has lost in colliding with the atoms of metal.

The two California physicists and the

two from Harvard have measured hundreds of such tracks. Two facts emerge from their research: first, that one group of particles fits into the curves of the Bethe-Heitler theory of energy loss with comforting snugness; second, that another group has a definitely lower rate of loss than the law allows, and is consequently far more penetrating. Such particles zip through depths of atmosphere or shields of lead impassable to the others. A further distinction between the two groups is also apparent. The law-abiding category consists almost entirely of "shower particles,"[1] while the others occur singly, rarely even producing showers.

There were similarities, however, as well as differences. All the particles were obviously electrically charged, like electrons or protons. Their tracks were there to prove it, for the uncharged neutron or photon leaves no such visible trace of its passage through a cloud chamber. Then again, all the tracks were of comparable width and length.

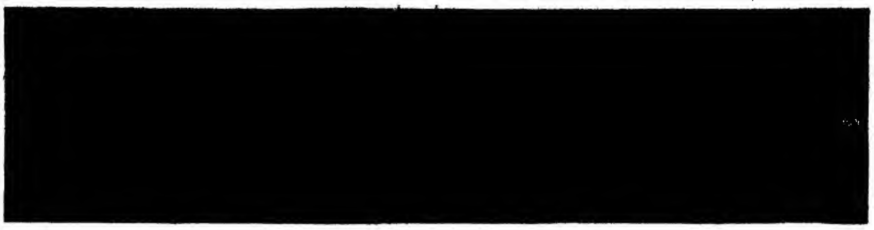
FROM previous studies, the shower particles were known to be positive and negative electrons. It seemed logical to suppose that the more penetrating group also consisted of electrons, or at least closely related particles, since their narrow tracks were so much alike. Had they been protons or other more massive or more highly charged ions, they would have cut a broader swath through the cloud chamber. Moreover, protons would need tremendous energies to produce the six or seven centimeter tracks observed for the X-particles. Yet the curvatures measured indicated a much lower energy range. And again, like electrons and unlike protons or any other known particle, the new group had both positively and negatively charged components.

Here, then, was the problem: Given two apparently similar particles, why should one behave in a normal, orderly fashion, while the other shatters theories right and left? Why should one travel through space in single splendor, the other in the company of showers? If both are really electrons, as they seem, why should one be far more penetrating than its twin? From what source does it derive its extra liveliness, and what special, innate quality distinguishes it from its more sluggish brother?

In the quantum theory, charge and mass are the only two parameters which characterize the electron. The experimenters were sure that their new, swift particle bore the same unit plus or minus charge. That left them only the mass to vary. What if the X-particle were simply a "heavy electron", its weight intermediate between that of the normal electron and the proton which is roughly 1850 times as heavy?

[1]A cosmic ray "shower" is a burst of from two to hundreds of particles, chiefly positive and negative electrons. Sometimes they are all exploded simultaneously from the same nucleus by the violent impact of a cosmic ray projectile. But more commonly the showers are cumulative, building up in steps from a single impact. In this case, an incoming electron interacts with a nucleus in its path to produce a photon (particle of radiant energy). The photon interacts with another nucleus to produce a positive and negative electron pair. The pair goes on to radiate new photons, the photons produce new pairs, and so on until all the original energy is dissipated.

The trail of a cosmic ray X-particle, photographed by Corson and Brode at the University of California. By measuring the curvature of the track and by counting under a microscope the number of ions per centimeter, they figured that the particle must weigh at least 185 times as much as a normal electron



The trail of a normal cosmic ray electron, photographed by Corson and Brode under exactly the same conditions as the one above. Note how much less densely ionized the track is, compared with that left by the heavier particle

There was one logical way to test such an hypothesis, and that was to weigh the X-particle. Street and Stevenson, its co-discoverers, were the first to think up and carry out that delicate experiment. If the particle were really heavier, they argued, it should leave a more dense track than a normal electron of the same energy—not so much denser that it could be detected at first glance, but enough so that it might, with care, be measured.

The tracks themselves consist of ions, atoms which have had an electron or two knocked from their outer structure by a particle shooting through the cloud chamber. The usual procedure in photographing such cosmic ray trails is to gear the camera shutter to click almost simultaneously with the passage of the particle, so that the lines are clear-cut and sharp. Street and Stevenson timed theirs to take the picture a second or so after the traversal. In the interval the tracks spread and diffuse a little, so that one can see and count the ions individually.[2]

The mass can be figured out from a complex, relativistic form of the simple and familiar equation, $E=\frac{1}{2}mv^2$. E, the energy, can be calculated from the curvature of the track or the length of its range. The number of ions per centimeter of track gives the clue to the velocity, v. Having computed these two quantities, Street and Stevenson proceded to solve the equation for its only unknown, m, the mass of the X-particle.

[2]Strictly speaking, it is the condensation of moisture on the ions, forming tiny fog droplets, which makes it possible to photograph and count them.

Out of some thousand photographs, they found only two tracks of unusual ionization. One was the easily identifiable trail of a proton. Subjected to the above calculations, the other particle proved to weigh about 130 times as much as an ordinary electron at rest.

In the meantime, other physicists have been at work trying to "weigh" other X-particles. Notable among them are Dale R. Corson and Robert B. Brode of the University of California, and A. J. Ruhlig and H. R. Crane of the University of Michigan. The latter two photographed a densely ionized cosmic ray track, made by a particle which they figured weighed some 120 times as much as the electron. At the date of writing, Corson and Brode had obtained and measured two more significant tracks. The masses disclosed for these were, by Street and Stevenson's method of calculation, 185 and 200 times normal. They believe, however, that the values should be even higher, based on a different relation between ionization and velocity from that used by Street and Stevenson. Dr. Corson and Professor Brode are carrying out further experiments to clear up their disagreement on this technicality. But whatever the results, they will not dispose of the X-particle dilemma.

OUT in St. Louis, Dr. George E. M. Jauncey, an able Washington University physicist, had an attractive idea. If cosmic rays contain what appear to be heavy electrons, perhaps some of the fast electrons shooting out from radium—the so-called beta rays—might also be heavier than normal. If so, that was a possible answer to the "beta ray paradox" which has long annoyed everyone connected with the study of radioactivity.

The paradox is briefly this. When a

radioactive atom spontaneously throws off radiation, it disintegrates into another variety of atom. There is a perfectly definite difference of intrinsic energy between the two kinds and, according to the conservation law, the radiation emitted should carry off exactly that energy difference. But in cases of beta ray disintegration, this is not always true.

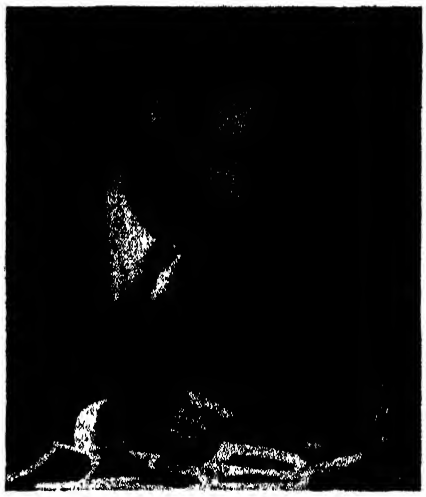
Assuming that all the electrons taking part in any given transformation have the same mass, then they should also start out with the same velocity. Instead, they vary through a whole spectrum of speeds less than that required. To account for the missing energy, the "neutrino" was invented. This tiny particle was supposed to be electrically neutral, and to have just enough mass to make up for what its electron partner lacked in speed. Unfortunately, no one was ever able to discover the neutrino experimentally or prove that it actually existed.

But let us return to St. Louis and Dr. Jauncey. Last fall, he became entranced with the idea that the neutrino might not be a separate particle at all. Suppose its weight were incorporated, so to speak, in the body of a heavy electron. If he could thus neatly dispose of the dubious neutrino and identify the puzzling X-particle by the same maneuver, that would indeed be a coup d'état.

THE experiment he devised to prove his point used radium E as a source of beta rays. These electrons he filtered through a velocity selector—a tube with electric and magnetic fields crossed at right angles, allowing only particles of a certain speed to pass on through into a magnetic field alone—and thence to a photographic plate. Electrons with the same velocity and mass should all experience the same pull in the magnetic field, and all land on the same place on the plate. But electrons with the same speed and *greater* mass should deviate less in the field and leave their mark on a different part of the plate.

When Dr. Jauncey developed his films, he found, as he hoped, that the electrons had not all landed on the same spot. Indeed, they had scattered themselves in such a way as to indicate that some weighed as much as two and a half times normal.

The reactions to Jauncey's theory and experiment have been warmly critical, and the pages of the august *Physical Review* have for months been the scene of much polite wrangling over the X-particle. C. T. Zahn and A. H. Spees at the University of Michigan immediately pointed out that they had entertained the same notion before Jauncey did, had tested it with extensive experiments remeasuring the ratio of charge to mass for beta rays, and had found no significant variation from the classic value. Jauncey retaliated by saying that, in their experiment, their apparatus would automatically exclude "heavy electrons", leaving only ordinaries to be measured. Zahn and Spees retorted that Jauncey had misinterpreted his own data, and that the extra lines on his film were in all probability caused by leakage and scattering of electrons of other speeds in his velocity selector. Dr. Arthur Holley Compton of the University of Chicago, Nobel Prizeman and an outstanding cosmic ray authority, looked at first with sympathy on Jauncey's experiment and his interpretation of it, then changed his mind and offered an alternative explanation in agreement with Zahn and Spees.



Dr. Carl D. Anderson, "Cal Tech" Nobel Prizeman, particle finder

Another blast came from the south, where Arthur Ruark and Creighton C. Jones had been doing conservation of energy experiments at the University of North Carolina. They remeasured 15 excellent tracks showing collisions between beta rays and electrons, photographed by Champion at Cambridge University in 1932. Fourteen gave perfectly clear-cut evidence that the beta particles were normal electrons. The fifteenth, while apparently not conforming to the conservation law, was probably a different kind of collision, and in any case could not be explained on the hypothesis that the beta particle in question was extra heavy.

At the University of Michigan, H. R. Crane sounded still another note of discord. He reported negative results on an experiment trying to prove that some beta rays were more penetrating than others, as they should be were they analogous to the penetrating X-particles in cosmic rays.

Though somewhat dizzied by all these attacks and counter-attacks, the layman can nevertheless accept the X-particle as a physical reality and as a component of cosmic radiation. On the question of whether or not it is a universally occurring heavy electron, he had best keep an open mind, at least for the present.

What about the origin of the X-particle? Dr. Jauncey believes that it acquires its extra weight by collision with a photon, absorbing at the impact part or all of its radiant energy in the form of mass. He computed that the particle weighed by Dr. Street, for instance, must have absorbed a photon representing an energy of 4,000,000,000 electron volts to account for its avoirdupois. Dr. Neddermeyer suggests that, since positive and negative X-particles occur in approximately equal numbers, they are perhaps created in pairs like ordinary electron secondaries exploded from a nucleus after a violent collision. But these are only guesses, and, at this early stage of the game, one guess is as good as another.

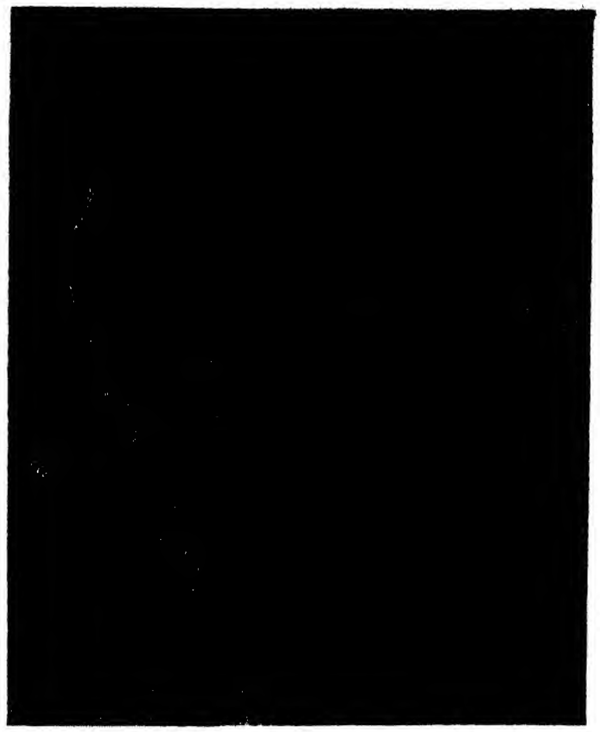
NO more is known about the fate of the X-particle than about its origin. The logical continuation of Jauncey's theory would demand that the extra mass absorbed from a photon be released eventually in the same form of radiation. On the other hand, Dr. Street has found that a heavy particle whose original energy lies somewhere in the billion volt range will retain its great penetrating power for a while, losing its momentum gradually and regularly until it reaches a critical value at about 400,000,000 volts or less. After that, a chance encounter with another particle may set off an explosion that blows them both to bits. When and why this happens, and what the final cataclysm is like, Dr. Street does not know yet.

It is also too soon for anyone to know whether or not the X-particle's mass is always the same. The values obtained have varied all the way from Jauncey's 2.4 to Corson's 200. The measurements made by counting ions at least give results of the same order of magnitude, but, as Neddermeyer points out, it would be all but impossible to detect a particle only slightly heavier than the electron by this method.

Jauncey, of course, believes that the mass *is* variable to any extent, a necessary adjunct to his anti-neutrino theory. Others have suggested that the quantum theory may apply, and the mass may vary only by units.

Every month, every week, every day brings further data to bear on the problem of the X-particle—what it is, how much it weighs, where it comes from, where it goes. If Jauncey is right, if it is really only an electron in disguise, then revolution is imminent in atomic physics, spectroscopy, quantum mechanics, and all the related fields where the constancy of the rest mass of the electron has been a basic tenet. If Jauncey is wrong, one can still expect radical changes in the theories which must now account for an atomic family of six instead of five fundamental particles.

SHASTA DAM



Site of Shasta Dam, at left; and, above, the plan, with dimensions. Note the luxuriant vegetation

Will Be World's Second Highest . . . Primary Function—to Conserve and Regulate Water Resources of Sacramento River Valley . . . 560 Feet High

REVISED plans for Shasta Dam, key unit of the vast Central Valley project in California, will make it the second highest concrete dam in the world.

The design approved by Bureau of Reclamation engineers calls for a straight-gravity concrete dam approximately 560 feet high and 3100 feet long, to be erected across the canyon of the upper Sacramento River, 13 miles north of Redding, California. The dam will back up the waters of three rivers—the Sacramento, Pit, and McCloud—a distance of 35 miles to create a conservation reservoir with a storage capacity of 4,500,000 acre-feet.

As originally planned by state engineers, Shasta Dam was to be about 500 feet high, creating a reservoir of approximately 3,000,000 acre-feet. On the basis of recent comprehensive studies of the economic height, considering the water resources and the manifold requirements, Chief Engineer R. F. Walter, of the Bureau of Reclamation, approved a recommendation for a reservoir of 4,500,000 acre-feet.

This storage capacity at the selected site requires a dam with a crest elevation 543 feet above the present lowest bedrock determined by foundation exploration. After excavation for the necessary cut-off wall below bedrock, the dam will rise probably about 560 feet above the lowest foundation.

Shasta Dam's only rivals in size will be mighty Boulder Dam on the Colorado River and Grand Coulee Dam under construction on the Columbia River, both under the jurisdiction of the Bureau of Reclamation.

IN height, Shasta will be second to Boulder, which is 726.4 feet high. Grand Coulee will be 553 feet high. On the crest, Shasta will be more than twice as long as Boulder—3100 feet compared with 1282 feet—but not as long as Grand Coulee's 4200 feet. In mass, Shasta will require approximately 5,700,000 cubic yards of concrete, which is considerably more than the 4,360,000 cubic yards in Boulder Dam and power-house, but hardly comparable with the 11,250,000 cubic yards now being placed in Grand Coulee Dam and power-houses, now under construction.

Next to these three giants is the Chambon Dam in France, 450 feet high, followed by Hetch Hetchy Dam, a part of San Francisco's water-supply system in the Sierra Nevadas, which recently was heightened to 427 feet, and Owyhee Dam in eastern Oregon, another Bureau of Reclamation structure, which is 417 feet high.

Walker R. Young, of Sacramento, the Bureau's construction engineer for the Central Valley project, who also was the construction engineer on Boulder Dam, said Shasta Dam will require concrete enough to build a solid monument a city block square and slightly higher than New York's Empire State Building. He said it would take a freight train more than 200 miles long to haul the cement to be used in mixing this concrete; and that Shasta Reservoir, when full, will hold water enough to cover the entire city of Chicago to a depth of 35 feet.

Incidental to the primary functions of Shasta Dam will be the generation of about a billion and a half kilowatt-hours of electricity annually. The initial hydro-electric installation will be for 280,000 kilowatts (375,000 horsepower) capacity, with provision for future enlargement to 350,000 kilowatts (470,000 horsepower).

Shasta Dam will be one of two large concrete dams on the Central Valley project. The other, Friant Dam on the upper San Joaquin River east of Fresno, California, will be 260 feet high and 3330 feet long, creating a reservoir of 450,000 acre-feet. Shasta and Friant Reservoirs will be operated to conserve and regulate the principal water resources of the combined Sacramento and San Joaquin River valleys to serve a fertile agricultural empire partially threatened with reversion to desert by drought and salinity. More than a million acres in the Sacramento and San Joaquin basins face an acute water shortage which is expected to be relieved by the Central Valley project. —*The Reclamation Era.*

Aluminum Can Be Plated

Long Resisted All Efforts to Plate it . . . Final Success . . . Process is Cheap, Fast, and Practical . . . Will Greatly Expand Uses of Light Metal

By RAYMOND F. YATES

MUCH like television, electroplating aluminum by a practical, fast, and inexpensive method such as used for the modest metals, has been "just around the corner" for some 30 years. During this time, chemists, near-chemists, and tinkers, spurred on by the large financial rewards that have unquestionably awaited a solution to the problem, have gone about their many and devious ways to discover a method that would be commercially practicable. Aluminum has been doggedly recalcitrant; for years it has successfully and completely resisted every effort of the inventors.

Yet the industrial world has waited hopefully, and not without good reason, for it has been known that the application of aluminum in everyday use could be widened immensely and profitably if its chemically sensitive surface could be covered by a less chemically active metal such as nickel, copper, or chromium. Aluminum, like magnesium and the members of the alkaline group of metals, has a perfectly gluttonous appetite for oxygen and this alone has been the bugaboo, for the oxygen forms a plating-resistant coating of aluminum oxide as fast as fresh surfaces are exposed. Also, this oxide, this thin skin of rapidly formed Al_2O_3, is anything but agreeable, especially in cases where articles must be handled. In such cases, the hands of the user soon become covered with a gray, greasy-like substance that suggests lead. This is true not only for virgin aluminum but also for its more "hardboiled" alloys. Moreover, other base alloys having even a small percentage of aluminum demonstrate a healthy and convincing resistance to electroplating.

AT the present time, the world consumes about 375,000,000 pounds of aluminum annually. It is estimated that this figure could be greatly increased by a chemically resistant plating. Aluminum, after all, is more abundant in the surface of the earth than iron. One of the things standing between it and a much-anticipated Aluminum Age is the persistent film of oxide less than a thousandth of an inch in thickness. Charles Hall's gift of cheap aluminum to humanity was great and good but its complete utilization has been blocked by a "dog in the manger" skin invisible to the naked eye.

Nearly 20 years ago, an obscure chemist, William J. Travers, working in his small laboratory, vowed to break down this skin, to give aluminum a bright, lustrous coat that would place that metal higher in the esteem of the world. The dogged persistence of the man was inspiring. Failure followed failure so rapidly that a person with less perseverance would have cracked under the strain of disappointment. But not Travers. He had an Edisonian philosophy about the matter; he was one of those psychologically strange fellows who thrive on failure. Indeed, each of his failures narrowed the possibilities and helped to isolate the final answer. He could plate aluminum early in the game, but the process was a painfully slow and costly one not reducible to commercial practice. He aimed at forming a plating sisterhood between aluminum and brass, copper, and the other easily plated metals. Others had plated aluminum before him but every process was a precarious wedding of metals always faced with the likelihood of an easy divorce.

A large variety of common aluminum products may now be plated to stop corrosion, permit handling without smudging

Travers' efforts continued and were finally rewarded when the United States Patent Office issued patent number 1,971,761 wherein was recorded the culmination of 20 years of devotion to a single cause. At last aluminum could be admitted in volume into an ordinary plating establishment; and the electroplater could use the methods that were employed in the normal course of plating the common metals.

One of the strange features of the process which is now beginning its commercial début is that it is initiated by stimulating the very thing that it sets out to defeat—the formation of what is known as an anodic oxide film. It so happens that oxidation of aluminum surfaces can be immensely accelerated by having the aluminum form the anode in an electrolytic bath made up of one of a number of solutions that will yield oxygen. Preparation for this anodic process, which leaves the aluminum surface mechanically hard and resistant, is made by a brief immersion in a cleanser such as sodium cyanide. After rinsing in clean water, the freshly anodized aluminum is placed in an alkaline bath for a second time but here mere cleaning is not the object; rather, the inventor has found that this second exposure to the alkaline solution modifies the anodic oxide film and prepares the surface for plating by the ordinary process. Once the aluminum emerges from this second bath in the alkaline solution and is dipped in clean water, it takes its place beside either brass or copper and, indeed, goes through the same process of plating with the same time element, the same solutions. Usually it receives a base coating of nickel, like other metals, before it is re-plated with its ultimate covering of chromium, silver, copper, or zinc, as the case may be.

In a sense, Travers really overshot his mark in plating aluminum. For some

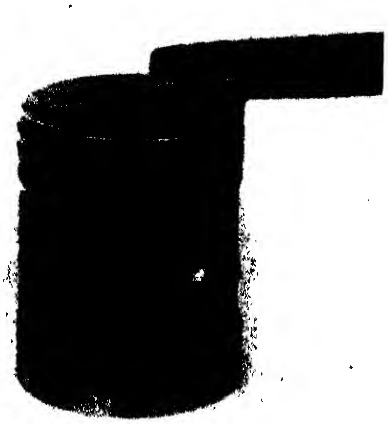
mysterious reason still not understood by chemists, the plated surface of aluminum often shows more resistance to removal than do plated surfaces on other common metals. Corrosion tests with salt spray, as specified by the United States Navy, yield amazing results as regards time of exposure. Then, too, chromium-plated aluminum pieces have been shuttled between refrigeration, at 30 degrees below zero, and hot spray cabinets for weeks on end without showing up any the worse for wear, although the uncoated metal was known to heave and twist in the throes of contraction and expansion. Here an uncanny factor appears to enter the calculations. The bond between the metals is obviously a new one. Therein may lie a new and important discovery in plating, once the chemistry and physics of the matter are known.

The field for the application of the Travers process is so wide as to be almost unbelievable. Designing engineers may now, for the first time, proceed to employ aluminum sheets and sand or die castings with the same abandon as they formerly employed in making use of castings of bronze, brass, or iron. Especially interested will be the manufacturers of articles wherein weight and eye appeal have heretofore fought a hard-to-decide battle to determine the prime factor. Already a large camera manufacturer has recognized the Travers process as offering a solution to a really light, strong, and attractive pocket-size article that will not make the carrier appear as though he has curvature of the spine. Many of the streamline trains that are now flashing over the countryside have their dining cars serviced with glistening trays of chromium-plated aluminum that no longer soil the hands of the waiter or leave streaks of gray on the spotless linen.

MILADY also stands to benefit from easy-to-clean chromium-plated ware that needs only the damp cloth to restore fully its pristine luster. After three years of use over a gas flame, a tea kettle emerges from the experience as fresh, as clean, and as beautiful as its still-unsold counterparts in the stores.

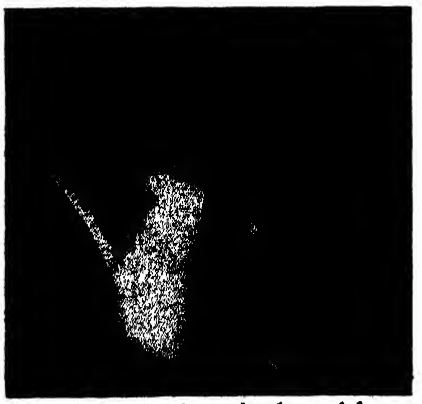
Already, the airplane manufacturers are turning to this new plated aluminum. After all, aluminum is the true "sky metal." For a given tensile strength, it has minimum weight, costs less to carry aloft. It would also have been widely used in the cabin trim of cruisers in the past had it been able to retain its buffed luster. One large manufacturer of planes has already employed chromium-plated pistons in pneumatic brakes. In such service, the chromium surface is ideal; it shows a great resistance to wear and insures a tightly sealed cylinder.

From the standpoint of weight, of course, the aluminum piston is the ideal for the gasoline motor. Cast iron pistons—six or eight to the motor—are great wasters of power in a reciprocating machine. Such pistons move with high speed within the cylinders and they must be arrested in their motion and reversed many times a minute. In such cases, the laws of momentum and inertia have been found to be brutally uncompromising. Being lighter by less than one half, the aluminum piston provides a greater output in power and gives greater acceleration. However, the bare aluminum piston does not wear well and, after a few thousand miles of travel, brings about oil dilution and heavy carbonization. In a few cases, such pistons have been given an anodized surface and, while this process does increase the useful life of such articles, it does not supply the final answer.



Soldering to chromium plated on aluminum to show tenacity of bond

When the Travers process was first announced, automotive engineers employed by several of the largest producers immediately interested themselves in the prospects of a chromium-plated aluminum piston. At the present time, tests are being conducted along this line. First, these engineers sought to find whether or not the high heat and the factors of expansion and contraction would adversely affect the plating. Long experiments have shown that it does not. A recently issued report from the experimental laboratory of one of the large automobile manufacturers has this to say about the tests that have been conducted in connection with Travers-plated pistons:



A plated aluminum kettle used for three years without injury to surface

"A set of pistons was sent to Mr. Travers and plated. These pistons were ground .006 of an inch undersize on the skirt, .004 to .006 of an inch undersize on the lands and .002 of an inch oversize on the ring groove width.

"On previous tests with chrome-plated aluminum pistons, it was found that the chrome plate flaked off after a 25-hour run at 3800 revolutions per minute full load. The expected failure did not materialize and the pistons were subsequently given 25 hours full load tests at 3000, 2000, and 500 revolutions per minute. Pistons were inspected after each 25-hour test and found to be in good condition. Cylinders numbered 3 and 4 were then pre-ignited for 10 minutes at 3000 revolutions per minute with no effect other than to improve the polish on the pistons.

"Piston clearance was checked with feelers when the pistons were installed and again at the conclusion of the above tests. Results given below are pounds pull on a .002 of an inch feeler.

Piston	*Before Test*	*After Test*
1	12 pounds	11 pounds
2	15 pounds	10 pounds
3	20 pounds	11 pounds
4	7 pounds	2 pounds
5	16 pounds	14 pounds
6	20 pounds	14 pounds
7	16 pounds	11 pounds
8	16 pounds	12 pounds

"FOR further work, four of the plated pistons were replaced by production pistons in order to serve as an index of the severity of the scuffing tests. The first test consisted of 2½ hours of full-load operation at 500 revolutions per minute with the choke closed as much as would still permit the engine to fire regularly. This gave excessive dilution and presumably greatly reduced the viscosity of the oil upon the cylinder walls. The engine was then used for several weeks in the cold room for carbureter starting tests. As the pistons were still in good condition, the bleed holes in the connecting rods were plugged. The engine was returned to the cold room and subjected to 24 starts in accordance with the normal scuffing procedure. It was later given a more severe test in which the engine was started 24 times and operated at full load at 400 revolutions per minute as soon as possible.

"At the conclusion of these tests, the aluminum pistons showed some scuffing, but the chrome-plated pistons appeared to be in perfect condition."

This one example of results gives the key to some of the future possibilities of electroplated aluminum.

Out Where the Vets Begin

Work of Modern Veterinarians Vital to Human Health . . . People "Catch" Many Serious Animal Diseases . . . Vets Study and Rigidly Control Them

By EDITH M. STERN

SOME years ago in Georgia, an inspector of the Bureau of Animal Industry ordered a group of farmers to dip their cattle for ticks. Suspiciously, the Georgians watched him mix the dipping solution. Still more suspiciously they looked on while he drove the animals through the vat. After the last cow had been dipped, so the story goes, one of the farmers wheeled about and shot the inspector.

Millions of animals have been inspected by government veterinarians since, and there have been plenty of other instances of opposition as bigoted and sensational. Dipping vats have been blown up by dynamite; guns have been used to force inspectors off the premises. In New York State, a die-hard old farmer took his cows, among the last that were to be tested for tuberculosis in that area, into the barn and killed them just before the veterinarian arrived.

These incidents, however, have never deterred the Bureau in the campaign it has waged since 1884 to make the animal kingdom safe for our democracy.

Though you may never have been nearer a farm than Broadway, this work directly affects your life. It was one of the Bureau's employes, Theobald Smith, who proved in 1890 that cattle fever was transmitted by ticks. Not only was his discovery the first step in the present victory over a disease costly to livestock owners—ticks, according to the Bureau, "carry off more cattle than the old thieves did"—but it first established the now familiar fact that every insect carries disease germs. Old timers in the Bureau like to recall how often Walter Reed, when he was doing his work on yellow fever, used to drop in at their offices to confer with them; how his tracing it to mosquitoes was a direct outgrowth of their colleague's findings. Likewise, knowledge that typhus fever and bubonic plague are carried by fleas grew out of Smith's research in a disease of animals.

Thanks to the Bureau, the milk you drink is practically free from tuberculosis germs; thanks to 800 veterinarians who work in its meat inspection division, the government-inspected meat you eat is free of disease, decay, and dirt; and the animal pharmaceutical products your physician prescribes, such as insulin, thyroid, and pepsin, come from healthy animals.

The results of its work in animal health have been quite as amazing as those in the field of human health. Eleven of the 35 most important diseases of livestock are today completely absent in this country and, because of the rigid inspection maintained at ports, unlikely ever to be imported or re-imported. Not a single case of dourine (horse syphilis), for example, was found last year. Imported from France into Illinois in 1886, it spread quickly to Montana, and by 1902 it was found as far south as New Mexico. Through the slaughter of infected animals, gradually it became restricted to only a small area of Indian territory in northern Nevada. Today even that area, in professional terminology, is "clean."

SEVENTEEN of the 24 remaining diseases are either effectively controlled or approaching complete eradication. Southern cattle fever, formerly prevalent throughout 15 states, has been reduced to negligible proportions. Unremitting attacks, since 1906, with "Dip that tick" as the battle cry, have restricted it to small sections of two states, 4 percent of the area formerly affected. Hog cholera has been cut 60 percent by means of preventive serum. For many years losses from this malady alone cost swine owners $40,000,000 annually, and in the years of greater prevalence they rose as high as $70,000,000.

Perhaps the most widespread and complete of the Bureau's triumphs has been the virtual eradication of bovine tuberculosis. In 1917, when tuberculin tests were first made, it was found that, on an average, 5 percent of cattle were tuberculous, and in some sections the average was as high as 30 percent. It was not unusual, in those days, for the test to disclose that even on a gentleman farmer's model dairy farm, 80 percent of his pure-bred herd was infected. Today, in 46 of our 48 states, tuberculosis is present in less than 0.5 percent of cattle. Compare this situation with that in some European countries where 50 percent of the cattle are diseased. Compare it with England, where over 5 percent of all human deaths from tuberculosis are caused by infected milk, and 25 percent of all cases of non-pulmonary tuberculosis are traceable to this source. In the United States, although at least half the milk consumed is unpasteurized, humans who have contracted bovine tuberculosis are now so rare that medical schools find difficulty getting cases for clinical demonstration.

Two annual or three semi-annual tests which show a herd clean, entitle the owner to a certificate for having an accredited herd. However, most owners have become so convinced of the benefits of the test that, for their own reassurance, they continue to have their private veterinarians apply it. Getting a herd clean is one thing; keeping it so is another, and vigilance pays. Tuberculosis can be introduced into a clean herd by a bull imported for breeding. Its germs can lurk in barnyards for a long time and start up fresh troubles. Once the disease has gained a foothold, it increases progressively.

Pride of the tuberculosis eradication division of the Bureau is the herd at the Soldiers' Home in Washington. It was first tested—and found heavily infected—in 1918. Infected members were eliminated and it became the first accredited herd in the United States. Frequent tests have shown that it is still clean.

That there is today always a waiting list of herd owners eager to have their cattle tested, that 99 out of 100 farmers co-operate with the Bureau, is not only because they have seen results, but because of the Bureau's thoroughgoing educational as well as enforcement campaigns. It issues 67 publications on animal disease, of which 1,000,000 copies are annually sent out in answer to requests. Thirteen motion pictures dealing with disease control and livestock health were shown, in one year alone, to 80,000 people. These educational services promote public health while aiding farmers.

Skilled laboratory research lies back of the strong-arm work of inspection, testing, giving "shots," and dipping. For the modern D.V.M. (Doctor of Veterinary Medicine) is a scientist, and the old-fashioned horse doctor is as outmoded as the buggy his patients drove.

Not only members of the Bureau's staff, but any veterinarian who now is graduated from a veterinary school, must have at least a year of college work and four years of training in a school of veterinary medicine. Knowledge of bacteriology, pathology, and materia medica is as much a part of his equipment as it is of the physician's. Like the research worker in human diseases, he uses rabbits, guinea pigs, and mice as experimental subjects.

Because such herds of milkers are carefully inspected, bovine tuberculosis among humans in this country is kept very low

MOREOVER, his work is effective. High on a hill in Beltsville, Maryland, at the animal disease station, there is a herd of cows that look healthy enough, yet every one of them is afflicted with infectious abortion (Bang's disease). Some of them are about to calve, and white-coated, rubber-gloved men are watching eagerly to see how many of the calves come to a live birth. For three years now, fortified by a special appropriation, they have been waging intensive war against this highly contagious malady. Preventive vaccination has worked so far, and Bang's disease has been reduced two thirds by the energetic campaign of the last three years.

Veterinary medicine was kept alive by the Arabs during the middle ages, but it did not reach the dignity of an established profession until the first veterinary school was established in Lyons, France, in 1761. London followed with a school in 1791, and Berlin the next year. It was not until 1852, however, that a short-lived school was chartered in America. Other schools supplanted it and, until 1920, veterinary medical education was almost entirely in the hands of private commercial interests. Courses of from two to three years' duration were given, often without any educational prerequisites. When the Bureau was founded in 1884, there was great difficulty in assembling 18 qualified men for its staff.

Civil Service requirements for government positions, increasingly rigorous licensing, and higher professional standards showed up the inadequacies of the private school, and in 1928 the last of them closed its doors. Ten well equipped and competently staffed state institutions prepare veterinarians for their work today.

That work is highly complex. Though hog cholera, for instance, occurs only in swine, bovine tuberculosis takes its toll among swine as well as cattle and, to complicate matters still further, swine are more susceptible to the avian form of tuberculosis, which chickens have, than to the bovine! Quail are subject to an intestinal disease called ulcerative enteritis; chickens are not. Foxes in captivity have some of the same diseases as dogs, but take others that have never been observed in dogs or other domestic animals. The normal blood count differs in different species. And a mere list of the diseases which one classification of domestic animals alone may have is staggering. The Bureau's publication, *Diseases and Parasites of Poultry*, contains 69 pages of fine print and includes ailments with such fantastic names as bumblefoot, limber neck, and edema of the wattles, as well as the more familiar maladies like gout, paralysis, and malaria.

Small wonder that the Bureau's work abounds in specialties. For the past decade Dr. J. E. Shillinger of the Bureau of Biological Survey has been devoting himself exclusively to pioneer work in the field of wild-life disease. Though technically his department is not part of the Bureau of Animal Industry, his problems are related to theirs. Domestic and wild animals using the same pastures can infect one another; the wild, not having developed the immunities of the domesticated, are peculiarly subject to infection.

Attempts to control epidemics that periodically ravage wild animals and birds are prompted by more than nature lovers' sentiment. Infectious diseases introduced among foxes and minks can decimate fur farms; sometimes, after a show, half the valuable animals are wiped out. Quail breeding is still kept from being a practical and complete success because, although breeders have learned to maintain the adult birds under pen conditions and more eggs are laid than in the wild state, brooder pneumonia, ulcerative enteritis, and blackhead take heavy toll among the game farm stock.

Even the diseases of undesirables like rodents are now being studied. Within the past few years, bubonic plague has been found among ground squirrels in the west. Their fleas can spread it among humans, and Dr. Shillinger and the Bureau of Public Health are co-operating in a campaign of feeding them poisoned grain.

Wild or domestic animals' diseases are of direct concern to humans, and it is often difficult to draw a line between the domain of the veterinarian and the public health officer. Anthrax, rabies, glanders, and tularemia (rabbit fever) are infectious diseases of man as well as of animals. Typhoid, septic sore throat, diphtheria, smallpox, and tuberculosis are spread through milk from diseased cows. There are also human diseases which closely resemble corresponding animal maladies, though the exact relationship is not yet fully understood. And there are diseases, like undulant fever, which have the same causal agent as animal diseases with quite different manifestations.

Behind the inspectors and the laboratory scientists, is the presiding genius of Dr. John R. Mohler, chief of the Bureau since 1917 and perhaps the leading veterinarian of the world. President of the International Veterinary Congress, Dr. Mohler has been many times offered posts, at far more than his present salary, by various European nations.

DESPITE the increasing importance of veterinary work, there is only one veterinarian to every 13 physicians, to every 500 livestock owners, and to every 20,000 animals. For the time being, veterinary medicine is one of the few professions where the demand exceeds the supply. Whether this condition continues will depend upon what appropriation is given to the Bureau of Animal Industry, which now absorbs nearly a third of the doctors of veterinary medicine in the country. There is no lack of young men willing and eager to practice in a field of such economic importance to both livestock owners and consumers, so vital to public health. Schools of veterinary medicine are turning away thousands of applicants whom they cannot accommodate.

The veterinarian who sits up in a draughty barn all night with a sick animal, who jabs hypodermic needles into bulls, attends hogs when their backs are arched with cholera, or peers through his microscope, trying to isolate a germ that is taking heavy toll among pigeons, may not be coming in for his share of front page publicity, but he has the satisfaction of knowing that his work has a vital bearing on human life.

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

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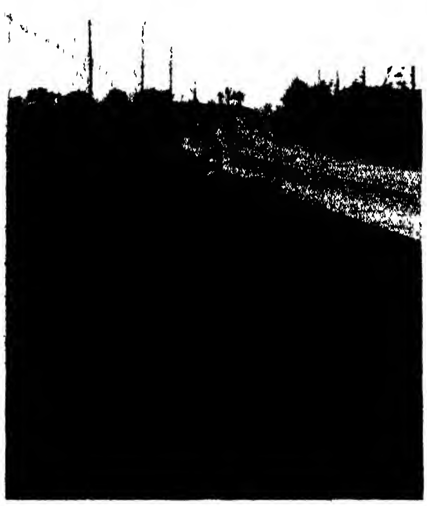
Chemical Engineer

NIGHT SAFETY

JUST as Michigan a quarter of a century or so ago assumed the leadership and became the world center for the manufacture of automobiles, so it has taken the lead in the installation of ultra-modern reflectors on one of its main highways for the promotion of safety in night driving. It is the only



Close-up view of one of the new "retro-directive" reflector units

public highway equipped with these new reflectors anywhere in the world. (See frontispiece, this issue, where a stretch of the highway is shown, outlined with the reflectors. In the photograph directly above may be seen one of the reflector standards as it is installed for service.)

This installation has been made on U. S. No. 16, an 85-mile stretch of main highway from Detroit, the state's largest city, to Lansing, the capital of the state, and was dedicated on the night of April 6, 1938. Headlights of the 40 or more cars carrying the dedication party beamed into new-type reflectors, 10 times as powerful as any heretofore in use, and outlined the highway far ahead of the drivers.

The new reflectors are a radical departure from those in more general use. They are made of Lucite (methyl methacrylate), the plastic recently perfected by duPont, that is water-clear, flexible, and non-shattering. This plastic molds much more accurately than glass and retains permanent transparency. It does not change color, but remains stable in service over a long period. The reflectors are set 100 feet apart on each side of the roadway, except at curves where they are slightly closer. The headlights from an automobile make it possible, as they are thrown on the reflectors, to outline the highway sufficiently for safe night driving.

Importance of the new reflectors to lessen night accidents is indicated by the fact that 60 percent of the fatal accidents in the United States and 48 percent of the personal injury accidents occur after dark, although only one third of all driving is done during this night period. Cost of the entire 85-mile project approximated much less than the average cost of a single grade separation. Operating costs, which are heavy for usual lighting projects, are eliminated by this new reflector method.

In these "retro-directive" reflector disks, no silver or metallic reflecting surfaces are used (which might deteriorate) because the cube corners themselves, although transparent, are none-the-less perfect prismatic reflectors.

The highway units are assembled for distribution by the Signal Service Corporation.

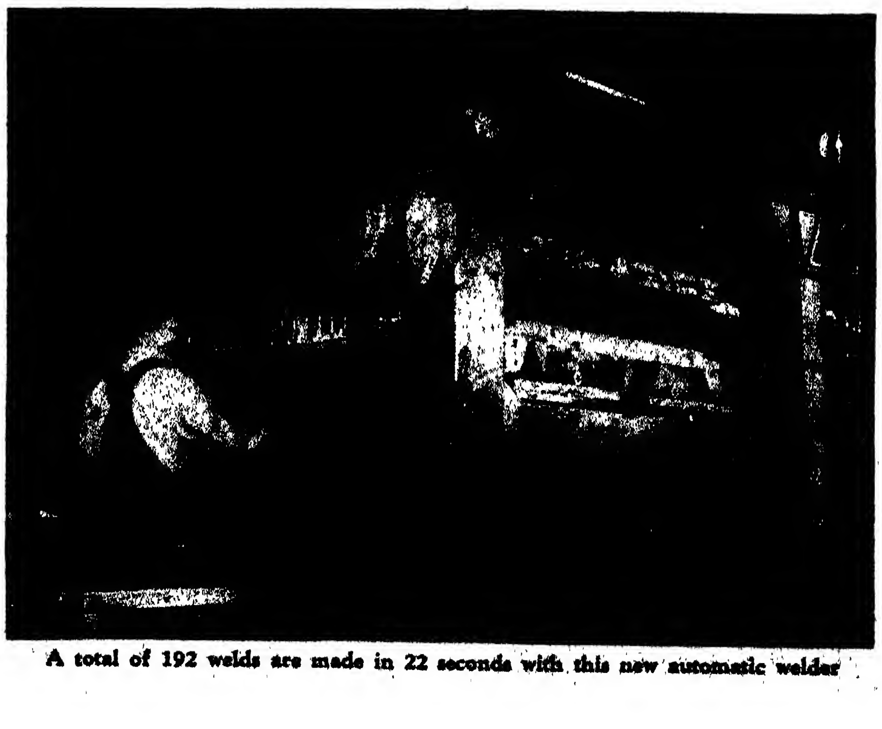
TWO PLASTICS FROM SOY BEANS

BY changing the moisture content of the protein of soy-bean meal, two different types of plastics can be made from it. With a moisture content below 5 percent, the plastics are like those made from zein, the protein of corn. If water be added to the protein, the plastic product resembles those from the casein of milk.—*D. H. K.*

LAST WORD IN WELDERS

ELMER WERK pushes a button in the body plant of the Hudson Motor Car Company, sparks begin to fly, and in exactly 22 seconds a total of 192 welds are completed.

The machine that does this work is known as a Multi-Hydromatic Welder. It welds re-



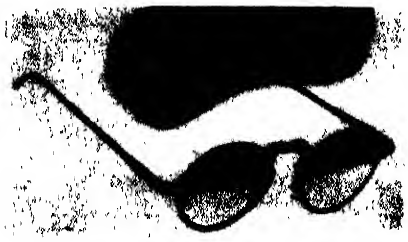
A total of 192 welds are made in 22 seconds with this new automatic welder

inforcements and wire clips to the underbody panel. The welds are completed on 14 major parts and five small parts on this panel, in one operation.

The push on the button by the operator automatically moves the table carrying the work into position, starts the welding, and, at the proper instant, 22 seconds later, stops the welding. Releasing a lever returns the table to its original position. It takes 38 seconds to remove the welded unit and set the machine for the next weld.

Safety Goggle for Motorists

AN ingenious product to combat effectively and practically the dangerous direct glare of headlights is the new goggle of the American Spectacle Company, Inc., called Moto-Glas. Wearing it, motorists can



Tilt the head for night safety

safely and easily banish the fear of "direct glare" headlight blindness.

The method of operation is so simple that no instructions are needed. The glass itself is of one piece—the lower portion perfectly clear and the upper part gradually shaded from the center to the top of the lens, where the density is dark enough to dim the most blinding headlight, yet allowing the driver to see the side of the road and the oncoming car. The driver assumes a normal position of looking straight ahead while the road is clear. When approaching headlights flash across the eyes, just a slight downward tilt of the head affords glare protection and high visibility at the same time. As soon as the car has passed, the driver assumes a normal position and has clear vision through the clear portion of the glass.

DAMS

MORE than 2,800,000 farm and range-land dams have been built under the supervision of Soil Conservation Service engineers in the past three years.

Glass-Like, But Springy

BECAUSE it excels the best spring-steel in several respects, glass-like, clear, fused quartz is being used as springs to indicate minute differences in weight in the General Electric research laboratory at Schenectady.

Briefly, springs made of hair-like filaments of quartz can be stretched to ten or more times their original length and will return exactly; steel springs would undergo a permanent stretching. Quartz has an extremely high melting point, and quartz coils can be used at elevated temperatures; steel springs lose their temper at a relatively low temperature. Quartz spirals are not affected by any degree of humidity; steel is subject to corrosion. Quartz is practically invulnerable to the multitude of chemicals encountered in a laboratory; many affect steel. And, finally, quartz coils weigh far less than, and have resulting advantages over, corresponding steel springs.

***Above:* How coil springs of quartz fiber are wound. The three flames impinging on the fiber from the right soften it. *Right:* Quartz spring supporting glass "boat" within a tube. *Below:* One of the coils compared with a pencil**

In the laboratory investigations the quartz springs are usually suspended within a glass tube which is maintained at the desired temperature by immersion in an oil bath. A small glass "boat" suspended from the coil holds the sample under investigation. As the suspended sample varies in weight, so does the length of the quartz spring; and since the length of the spring is proportional to the weight, readings of length give accurate weight values. Measurements are made within an accuracy of a milligram, or 1/28,350th of an ounce.

The quartz springs are used in measuring weight changes of various materials, under different conditions of heat and humidity. In measuring the moisture absorption of cotton, the sample is suspended from the spring in a vacuum, and the stretch of the coil noted. As water vapor is introduced at different pressures, the amount of absorption can be determined by the increase in length of the spring. Another application has been in measuring the rates of decomposition, in high vacuums, of such materials as organic resins.

The quartz coils used in making the measurements are produced in the G-E research laboratory, out of rods of the fused material as produced in the Thomson Research Laboratory located at Lynn, Massachusetts. In the glass-blowing department of the laboratory at Schenectady a small section of a quarter-inch rod of the quartz is heated to more than 3000 degrees, Fahrenheit, with an oxyhydrogen flame. A sudden, straight pull is then applied, whereupon the quartz pulls out into a fiber of about six one-thousandths of an inch diameter—much as molasses candy stretches into threads. These threads, 15 or more feet in length, are calipered, and those within a quarter mil of the desired diameters are saved.

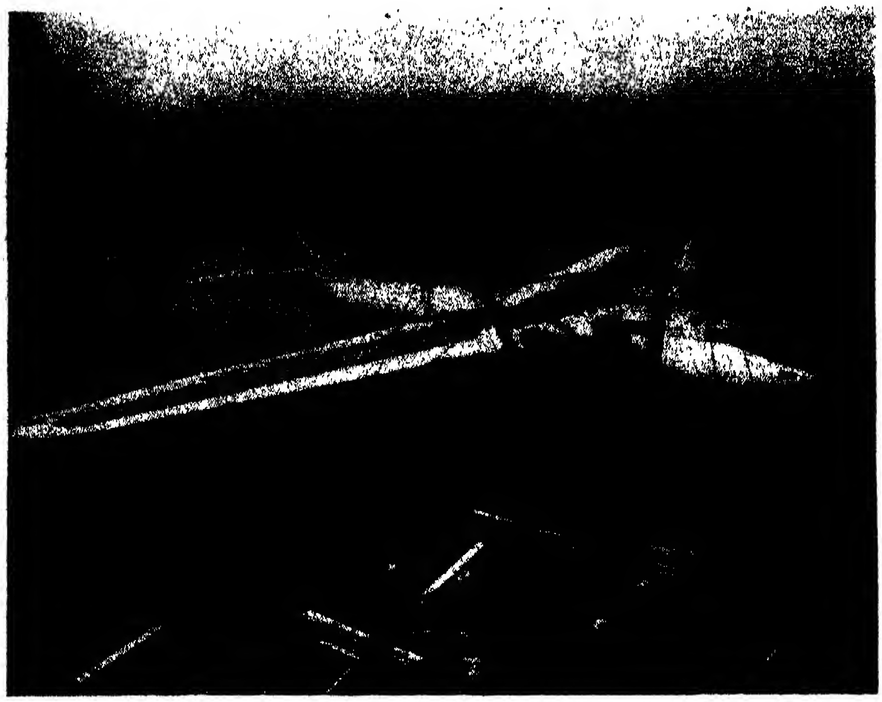
The thread is made into springs by placing it in a long, brass trough leading to a mandrel of the desired diameter. Three small flames of hydrogen in air, giving a temperature of 1800 degrees, Fahrenheit, soften the thread so that it can be coiled on the mandrel, which is being rotated at two revolutions per minute.

Some of the coils measure 3/8 of an inch in diameter and 1½ inches in length and have 50 turns to the inch; others are of 5/8 or 3/4 of an inch diameter and have as many as 80 turns to the inch.

The Boeing Clipper Progresses

THE hull of the world's largest flying boat, now being built by Boeing Aircraft for Pan-American Airways, has emerged from its construction scaffolding into the open. Accompanying photographs show the hull and wing center section of the 41-ton Clipper.

Six of these flying boats are to be constructed. One hull after the other will be put on a 15-ton eight-wheeled cradle of



The Boeing Clipper, with wings attached, resting on its special drydock. *Below:* View of the hull, showing the two inner engine nacelles

structural steel, with a series of air tanks to give it buoyancy, prior to launching.

The hull looks so large that it gives more the impression of a surface vessel than of an airplane. The hull measures 109 feet from bow to tail. It has an outside surface, glistening in aluminum, of 4000 square feet, and an inside volume equal to that of an average five-room house. The height of the hull is 19 feet. The tail surfaces measure 49 feet from tip to tip, the dimension of a fair-size wing. The gross weight will be 82.500 pounds. Each of the four engines (twin-row Wright Cyclones) develops 1500 horsepower; they are the largest of their type ever built. The propellers, of the constant-speed automatically-adjusting type, will have three blades and an over-all diameter of 14 feet. Fuel tanks in the wings and in the stubs, or wing stabilizers of the hull, will hold 4200 gallons of gas. Cargo holds in the center section of the wings and in the bow compartment will carry five tons of mail and air express. High speed will be approximately 200 miles an hour and cruising range will be 4000 miles with 40 passengers on board. There will be a crew of eight men. Roomy sleeping quarters are provided for the 40 passengers, with accommodation for 72 day passengers as an alternative.

A spiral staircase will connect the flight bridge or control quarters on the upper deck with the main deck which will contain a series of spacious passenger compartments, dining room, lounge, private suites, and so on.

We marvel to-day at the luxury and equipment of the *Normandie* and the *Queen Mary.* Some day our transatlantic flying boats may be a source of even greater wonder.—*A. K.*

The Russian Polar Weather Station

WHY did the Russian scientists endure the danger and discomfort of establishing a weather station on the ice floes of the north polar seas? Because the whole secret of weather is to be found in the high altitudes, and in the investigation of the travel of polar air masses. Everyone talks of polar mass analysis, but the fundamental principles of this new applied science are not generally understood. Following an exposition by Dr. Spilhaus, of New York University, we can set down the elements of the subject and show that it is not so very complicated after all.

The equator receives a great deal of the sun's heat, the air expands and flows to the polar regions. At the poles the warmer air collects, and drives the cold air downward until a rough equilibrium of heat exchange is established. Of course, millions of tons of air are involved in this gigantic equalization process. The study of these mass movements from equator to the poles, from the poles at high altitude to the equator, is the main concern of the modern meteorologist, and has enabled him to analyze and predict weather in a fashion which is infinitely superior to that of the old time weather man with his rudimentary notions of pressure gradients and with no real key to the phenomena involved. The Russian weather station was established mainly for a study of these air currents, but its members discovered some disconcerting facts which make the possibility of trans-polar air transport flight from Russia over the North Pole to northwestern America seem a little remote. The "warm" months in the Arctic are cursed by intolerable fog conditions. The winter months are equally cursed by very stormy weather, sometimes combined with fog.

What we need now is a string of weather stations along the Arctic fringe of Canada. Data from such stations, together with similar data now being gathered in northern Russia and Siberia, would in the end go far toward solving the secret of the cradle of the weather in the northern hemisphere. A beginning of this study has been made by the inauguration at Point Barrow, Alaska, of regular observations by automatic "radio-meteorographs" attached to pilot balloons. —*A. K.*

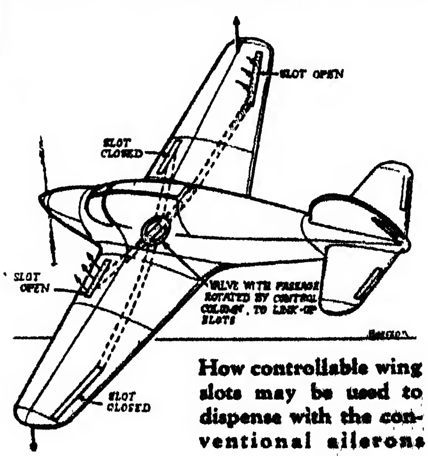
Airplane Control Without Moving Surfaces

BASIC new ideas in the aerodynamics of the airplane are comparatively rare. When we hear of a really new idea, we naturally feel some degree of excitement.

Ailerons give rise to flutter; they do not provide efficient control over the entire speed range; beyond the stall they may even give reverse control; as aircraft get larger, it becomes more and more difficult to actuate them.

A British patent, issued to Vickers Ltd. and D. L. Ellis, suggests the possibility of making use of the differences in pressure which exist over the surface of the wing, to dispense with moving ailerons entirely.

Over the leading edge of the wing there exists a pronounced degree of low pressure. Over the rear upper portion of the wing, there is less suction or even some degree of pressure. Why not interconnect the two points and secure lateral control thereby? The idea is illustrated by the diagrammatic sketch, reproduced by courtesy of the *Aeroplane.* A slot at the leading edge is connected through suitable conduits and a valve situated in the fuselage to a slot at the rear on the opposite wing. When, as shown in the sketch, the two slots are interconnected by the valve the following occurs: Lift is lost at the front slot, but increased at the rear outer slot. Since the outer slot has a greater leverage about the center line of the



How controllable wing slots may be used to dispense with the conventional ailerons

machine, a rolling couple or banking couple is created which is equivalent to the action of the ailerons.

Of course a patent only outlines such an idea. A great deal of experimentation would be necessary before it could be realized in practice. But the principle is correct, and it is our experience that when the aerodynamic principle is correct, the practical difficulties can eventually be conquered.

There is no reason also why the idea should not be extended, so that the suction of the front slot could be made to act on slots in the elevators and rudder. In that case, all moving surfaces would disappear.—*A. K.*

A Novel Idea in Jet Propulsion

THE aircraft engine radiator is always regarded as a source of air drag and of loss in performance. But two technical officers of the British Royal Aircraft Establishment have patented an idea whereby the cooling air passing around the radiators and cooling fins of the exhaust pipe will actually contribute to the thrust. Like all real ideas, this one has the merit of simplicity.

The entire engine with its exhaust manifolds is enclosed within the airfoil. Ducts in the leading edge allow slightly compressed air to enter the wing. The air then passes over the internal radiators and the finned exhaust pipe. In so doing it gathers heat, expands, and increases its speed. Then it exhausts through passages of gradually increasing area, so that its speed is converted into pressure. At exit the pressure is higher than that of the surrounding air. Therefore the stream exercises a backward thrust and a species of jet propulsion is produced. The heat released in cooling the engine is actually put to work! Of couse the device is hardly worth while for slow airplanes, but at speeds of over 300 miles an hour, the plan has considerable possibilities.—*A. K.*

Full Feathering Propellers

MANY of the new "hydromatic" full feathering propellers have been installed by United Air Lines on its transport

A full-feathering propeller with blades feathered through 90 degrees

When a stream of water, above, is directed on a gasoline fire, it has little or no effect. When a fog of water, however, is forced through a special nozzle (below) burning ceases almost immediately

planes. One of our photographs shows a pilot and a stewardess examining the blade of one of these propellers, "feathered" through a full 90 degrees, so that in flight it would be edgewise to the wind. Such 90-degree "feathering" has two great advantages: There is no "windmilling" or slow rotation of a propeller when the engine is not firing, and the head-on resistance of the feathered blade is reduced to a minimum. The importance of lowered resistance of the propeller in flying a twin-engined airplane with one motor out of commission is obvious.—*A. K.*

Fighting Fire With Water Fog

FIRE is a terrible danger in an airplane hangar. Hundreds of gallons of gasoline may be stored in the tanks of every machine. Fire in one aircraft may be followed by explosions in one ship after another, with enormous damage and great hazard to life. Roosevelt Field, Mineola, and other famous flying fields have been too often the scenes of disastrous fires. The use of water from an ordinary hose is useless; chemical fire extinguishers do not always prove effective. Since Los Angeles is perhaps the leading center of the aircraft industry it is entirely appropriate that Fire Chief G. Griswold of Los Angeles County should have developed a method of fighting fire with "water fog" which is proving remarkably effective in exhaustive tests.

The principle involved is simple. If wheat kernels are sprayed onto a fire, combustion of the wheat is slightly faster than that of wheat in bulk. When flour is shot into a fire through a nozzle, however, it explodes—combustion is instantaneous. Similarly when a stream of water is forced into a fire, there is but little effect. The water cools the surface of the material and reduces the production of burning vapor, but not rapidly enough. Chief Griswold's basic principle is to shoot two streams of water from nozzles in such fashion that the streams impinge upon one another, producing an exceedingly fine spray. The fine spray presents an enormously greater heat-absorbing area than the solid stream of water. Production of steam is instantaneous. The latent heat of steam—that is, the heat absorbed in turning water into steam—is relatively enormous. Thus in the production of the steam there is an exceedingly rapid absorption of heat. The burning vapor, in losing heat so rapidly, increases in density, oxygen is displaced by the downward motion of water fog, the mixture of air and burning vapor becomes too lean, and combustion ceases.

Water directed against burning wood may be an effective agent. Water directed against gasoline merely agitates the combustible matter and may actually increase the rate at which the fire spreads. But when the water impinges on gasoline in the form of steam, or water fog, combustion ceases very rapidly in spite of the low flash point of the gasoline.

These statements are supported by innumerable experiments of the Fog Nozzle Company. Because of the small quantity of water used, and the rapidity of the extinguishing process, material damage is reduced. This lessening of damage will be appreciated by anyone who has suffered

damage to household effects following even a small fire.

Thus the sciences of hydraulics and of thermodynamics combined have given the airport an entirely new and effective method of fire fighting.—*A. K.*

Perfected Fluorescent Lumiline Lamps

INVISIBLE sunrays, imprisoned within tubular glass bulbs, and bombarding chemical powders which serve as energy transformers, are now being used to produce

cool light sources that duplicate all the pastel tints of the rainbow.

The new light sources, designated as fluorescent lumiline lamps, provide hitherto unobtainable tints of colored light with, in some cases, as much as 120 times the illumination, for the current consumed, as filament lamps of the same color, and with only a fraction of the heat. One of them produces the nearest approach to natural daylight ever achieved by any artificial illuminant.

Fluorescent powders, compounded in the Nela Park laboratories of the General Electric Company and specially heat-treated, hold the secrets of efficiency and color-producing qualities of the new lamps, it has been revealed. Activated by ultra-violet, and functioning as transformers, the powders absorb the short, invisible ultra-violet rays and re-radiate this energy in those higher wavebands that comprise the color range of the spectrum. Each powder has its own characteristic wave-band with which it responds to the ultra-violet, thus forming its own particular color of emitted light.

Within the bulb of the new fluorescent lamp is a trace of mercury, a small amount of argon gas at low pressure, and a coating of the fluorescent powder. When the current is turned on, the argon serves as a "starter," and in a fraction of a second a feeble blue light with a large component of invisible ultra-violet radiation is generated inside the tube. The ultra-violet radiation strikes the fluorescent coating and is re-radiated in the visible range of the spectrum. Like all electric-discharge light sources, the fluorescent lamps require special transformers, or chokes, which serve as valves in controlling the flow of electric current. Unlike some other types of mercury-vapor lamps, however, they attain full brilliancy in a few seconds.

Among the many fields of application for

Left: Coating the inner walls of a new lumiline lamp. The fluorescent powder in solution is poured in; the excess is poured out. _Above:_ A set-up of five of the new lamps

the new fluorescent lamps might be listed the following: theaters, hotels, specialty shops, stores, beauty parlors, art galleries, architectural built-in lighting in many forms, railway cars, and so on.

SILVER

NEXT to the United States Mint, the Eastman Kodak Company is the largest single user of silver bullion in the country. To make photo-sensitive films and papers, that company uses five tons of silver bullion per week.

Celluloid Pipe Coatings

SEVERE corrosion of the outside of pipe lines carrying oil and gas across country requires special measures to be taken to prolong the life of the pipe. Cellulose nitrate plastic (Celluloid) has been successfully applied as a covering on cross-country pipe lines. The sheet of Celluloid is softened in a solution of ethyl acetate, alcohol, and water, wrapped around the cleaned and painted pipe and allowed to dry. The coating shrinks in the process and fits tightly around even the irregularities of the pipe. This apparently expensive treatment is justified by the much longer life of the pipe in service.—*D. H. K.*

Biblical Plagues Still Weaken Egypt's Health

THE Biblical plagues still afflict the land of Egypt.

Far from being a never-repeated reign of terror, the plagues with which Moses frightened a Pharaoh into releasing the Israelites were fearful because of their familiarity. And they still recur in more or less serious form.

The sequence of health hazards which the Nile brings each year was deplored recently before the World Federation of Education Associations by a physician of the government health service in Cairo, Dr. Isabel Garvice.

Pointing out the Biblical antiquity of these conditions, Dr. Garvice said that every August, then and now, the rising Nile turns blood-red from its load of heavy mud.

To drink this water is to invite sickness and death. Yet the Egyptian peasant is convinced that drinking well water would turn his hair gray and make him old before his time. Rather than risk such calamities, he clings to his year-'round habit of drinking from river or canal, and the blood-red water brings the plague of boils. The children, says Dr. Garvice, often have 10 to 20 boils on face and body.

As the flood waters lessen, come the plagues of frogs, flies, and death to the babies.

Even the three days of darkness, which enveloped the earth in the Bible siege of plagues, is still experienced. The darkness takes the form of sandstorms, which are still terrible in upper Egypt and still usually last three days.

"All these things," said Dr. Garvice, "are put down to the will of God and accepted with resignation by the peasant."

But the Egyptian government is determined to cope with its plagues. Children, under compulsory schooling, are being taught health habits and given medical attention. Rural villages are shown hygiene films. Medical centers are established. The conquest of the plagues is advancing—slowly.—Copyright, 1938, by *Science Service.*

And it Still Burns

STRANGE experiences have been undergone by Mazda lamps, but none, within knowledge, like that recently survived by the one shown at right in the accompanying photograph. Nor, in the opinion of Nela Park engineers, is it likely ever to be duplicated.

Used in a drop cord in an Oklahoma City ice-cream plant, the lamp was burning when a fire broke out. During the blaze, an ammonia tank exploded, crashed through the wall of the building, tore through an empty barn on the opposite side of the alley, then burst through the kitchen of a house on the near side of the next street, finally coming

An incandescent lamp, subjected to intense heat in a building fire, bulged but remained burning. It is here compared with a standard bulb

to rest on the front lawn of the house whose kitchen it had reduced to a shambles.

When the smoke and fumes cleared away, there was the lamp, which had been directly in the path of the explosion, still burning, although the combined heat and pressure had softened and distorted the bulb to its present odd shape. Had the heat blast been of longer duration by even a fraction of a second, the glass would have melted, with resultant lamp failure, say lamp experts.

The lamp, which continues to burn, is being preserved in a collection of lighting oddities in the General Electric Institute at Nela Park.

TRANSITION

STEAM enters a modern turbine at a temperature hot enough to set fire to a piece of wood and .03 of a second later leaves it at a temperature too cool for a comfortable bath.

Yerba de la Pulga

RECENTLY the Pan American Society of Tropical Research notified us that they have been successful in bringing back to this country nearly three million seeds of the species of plant known by its native name as "Yerba de la Pulga." Extensive experiments and observations indicate that this plant possesses exceptional insect-repelling qualities, and it is the Society's belief that the plant not only contains, but actually exudes, sufficient quantities of the drug "rotenone" to make a single growing specimen of the plant repellent to practically all forms of insect life in an area of some 15 to 20 square feet.

Since the Society desires to distribute these seeds to all who wish to experiment, they have asked us to say that they will send a small package to all readers requesting them between July 1 and August 1, provided a stamped self-addressed return envelope is enclosed with the request. The Society states that there is absolutely no obligation attached to this offer.

Anyone wishing to co-operate in this experiment may do so by sending the stamped envelope as requested to the Pan American Society of Tropical Research, Post Office Box 1698, New Orleans, Louisiana.

Hand Work by Electricity

TOOLS for cutting metal sheet and plate have been immensely improved in recent years, in the opinion of *Nickel Steel Topics*, both through ingenious design and the use of proper materials. This fact is well exemplified by the Unishears, manufactured by the Stanley-Electric Tool Division. This device is illustrated in one of the accompanying photographs.

Electrically driven, the Unishears are produced in three portable sizes capable of cutting thicknesses of from 18 to 12 gage in hot-rolled steel. It is stated that they will do any job that can be done by hand snips, and with much greater rapidity, up to 2400 shear cuts per minute. This high speed obviates distortion of metal, burrs, irregularities, and other causes of wasted metal. Cuts are accurately made in straight, curved, or angular lines. The device is available for all voltages.

Electrically driven, these portable metal shears have many applications

Similar "companion tools" are shown in two other illustrations. One of these shows the new Stanley Safety Saw, built for carpenters, builders, and plant maintenance men. This may be used as either a rip or crosscut saw for many kinds of hand work. It comes in varying voltages from 110 to 250.

The second "companion" is the new Carter "Wasp" Plane, which is adapted for use in many operations, such as fitting doors, window sash, screens, shutters, drawers, inside trim, and so on. Running at 18,000 revolutions per minute, the patented spiral cutter leaves a smooth, waveless surface. This device comes in voltages of 110 or 220 as specified, and the motor is universal.

An electrically driven plane speeds up many wood-working operations

Ripping or cross-cutting may be done with this portable power saw

Correction

UNDER the head "As Others See Us," we published in our June issue a brief item attributed to the *Sphere* of London commenting upon various facts concerning the population, production, and banking resources of the United States. This particular item had been reprinted in a number of places, each of which had given credit to the London magazine for original publication. It appears, however, from a note in the *New York Herald Tribune*, that this was originally published by a publication also called the *Sphere* but published in Washington, D. C. This fact voids the title of our brief item, though it does not in any way alter the facts or the opinions that were presented.

Three Miles Down!

FOR years oil men have been talking about drilling a well three miles deep. Three miles is exactly 15,840 feet. Now there's an oil well at Wasco, California, which has been drilled to, and is producing from, 15,010 feet below the surface!

Drilling began about 16 months and $300,000 ago. On January 31, 1938, the well equalled the world's record, 12,876 feet, and drilling was halted by temperatures of 225 degrees, and up. Difficulties were overcome, however, and drilling was resumed at the rate of 50 feet of six-inch hole a day. On April 12 last, the presence of oil indicated that the $300,000 had not been entirely wasted, and that eventually oil in paying quantities might be brought up through the 175 joints of steel casing, each 90 feet long.

It will require the sale of 7,500,000 gallons of gasoline, equivalent to the annual consumption of 10,000 passenger cars, to pay the cost of drilling—alone. That is, if the seller can make as much as the tax collector —four cents a gallon!

Silver Lined Cans

INVESTIGATIONS are being made of the possibility of lining cans for foodstuffs with silver in preference to tin. Even though silver is far more expensive it may be more desirable for some purposes.—*D. H. K.*

Copper for Diabetes

AN inquiring German physician, Dr. R. Schnetz, recently discovered that with the aid of copper, diabetics will be able to eat whatever they wish, according to an announcement by the Copper & Brass Research Association. Through experiments covering three years, Dr. Schnetz found that even though a diabetic consumed an un-

Courtesy Leeds, Tosser, and Co., Inc.

When a bus of the City Transit Company in Cincinnati, Ohio, is to be washed, it is driven to this "laundry." The driver turns on the headlights of the bus, the light from which strikes a photo-electric cell and starts the machinery. A spray of water thoroughly drenches the bus while motor-driven brushes scrub the sides, windows, and roof simultaneously as the bus is driven slowly through the washer. When the headlights are turned off, the washer stops. It requires only about 30 to 40 seconds for the job

usually large amount of sugar and starches, a small dose of copper kept the sugar-content of the blood at the right level. Insulin requirements could be materially reduced and, in slight cases of diabetes, might be dispensed with entirely if 10 to 20 milligrams of copper were substituted.

FLAMES

THE highest solar prominence ever recorded, observed by Mount Wilson Observatory recently, rose to a height of just under 1,000,000 miles from the sun's surface. Its highest rate of rise was 124 miles per second.

How Acid?—How Alkaline?

SUPERIOR to the old well-known litmus paper in many cases, a new wide-range test paper has just been placed on the market by R. P. Cargille. Its color changes total five, ranging from very strongly acid, which is red, and then through orange, yellow, green, to the strongly alkaline, which is deep blue. For the sake of convenience a color label is provided.

Such a test paper should prove valuable in many laboratories for process control, product testing, and analytical procedures.

It Weighs the Weather!

WHAT happens to a rain drop? That's exactly what the government is spending millions of dollars at the 8000-acre Coshocton (Ohio) Hydrologic Study to find out. For, involved in this apparently simple question is the whole problem of floods, erosion, and soil conservation. Here they are trying to find out how to make the valuable top-soil "stay put"; how to make it absorb a maximum of water. They are trying to find out how much rainfall evaporates, how much soaks in, how much runs off on various surfaces and types of soil. It is anticipated that to get an answer may involve 15 to 20 years of work.

To gather the vast amount of scientific data, it was necessary that a number of new testing devices be developed. One of the most interesting and important of these is the Toledo Lysimeter Scale.

This device can best be described by outlining the method of installation. The first step is to sink what amounts to a coffer dam around a block of soil approximately 7 by 15 feet. This goes down to a depth of 11 feet. The net result is that this block of soil is separated from the surrounding ground—yet its surface and composition is in no way disturbed. A supporting structure is placed around it and the unit mounted on scale levers. The accompanying photo was taken while construction was going on and gives some idea of how the device appears from the surface. The entire weighing mechanism is, of course, underground, and when construction work is finished, very little evidence of the device is apparent from above.

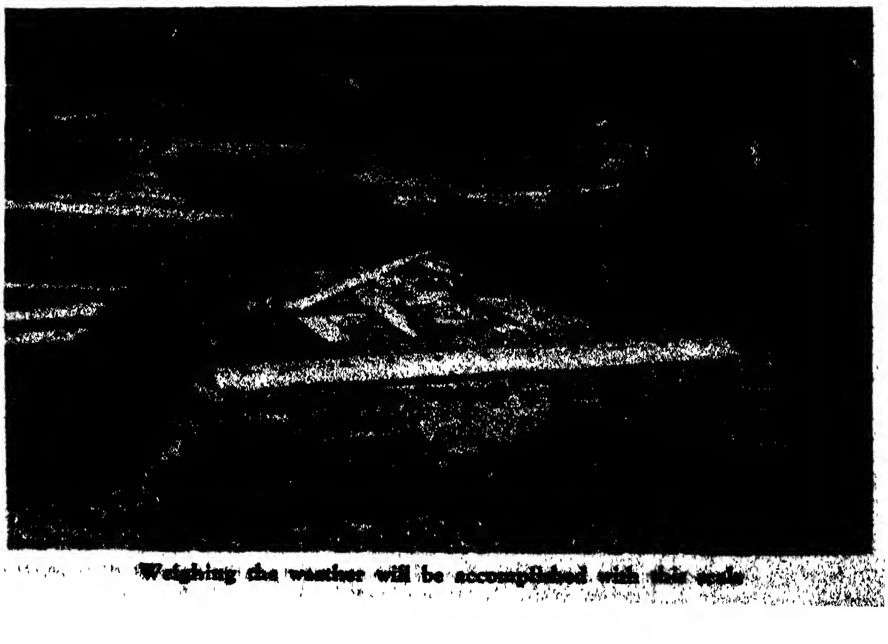
From a weighing standpoint a number of interesting problems were introduced. A mass of earth of this size weighs approximately 100,000 pounds. Yet all the scientists were concerned with were the variations in weight caused by gain or loss of moisture. So the scale was back-weighted for this 50-ton dead weight, and a dial of only 5000 pounds capacity was needed. Also they wished to have readings automatically taken at half-hour intervals. This is accomplished by the use of a continuous-strip Printweigh which has a special time-interval mechanism. As a result, the whole unit functions automatically and continuously.

What do they propose to learn from these records? Suppose during a rainstorm 50 pounds of water falls on this "miniature farm." There may be five pounds run-off from the surface. This is collected in a rain-gage for measurement. Another 20 pounds may seep through the soil (and be collected in another rain-gage at the bottom). That accounts for a total of 25 pounds. Then by checking the continuous strip record of the Printweigh it is found that the block of soil is 20 pounds heavier than before the rain. In other words, the soil has retained 20 pounds of moisture. This leaves five pounds unaccounted for—this being the amount that has evaporated. Through this equipment, every change in the moisture content of the soil is recorded.

By placing Lysimeters in various types of surfaces (grassy, plowed, eroded, etc.), a vast amount of information can be collected that will aid still further in putting agriculture on a scientific basis. And by finding which type of surface holds the maximum amount of moisture much can be done to prevent erosion and to control floods at their source.

Magic Eye in Chemistry

ELECTRON-RAY tubes, familiar in modern radio sets as the "eye" which shows when the set is in tune, are being applied to faster, more accurate chemical analysis. Changes of color of certain dyes have been



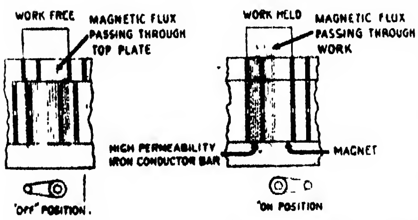
Weighing the weather will be accomplished with this scale

traditionally used to indicate the completeness of reactions measured in analysis. Because of the insensitivity of the dyes and of the eyes of the analyst to the color changes, attempts have been made to avoid their use. Most recent of the improvements in apparatus for chemical analysis is the inclusion of an electrical system operating an electron-ray tube which blinks at the exact end-point of the reaction measured.—*D. H. K.*

Magnetic Chuck

A NEW magnetic chuck that does not require electric current and is readily portable has just been developed by Brown & Sharpe Manufacturing Company. This new device is equipped with a permanent

Above: **The non-electric magnetic chuck in use.** ***Below:*** **How the magnetic flux is diverted from work**



magnet so that there are no wires, no heating, and no running costs. It is adapted to wet as well as dry grinding, as it is so completely sealed that coolant cannot enter the internal parts.

One of the accompanying illustrations shows the manner in which the magnetic flux is diverted, when the lever is on the "on" position, through the workpiece, thus holding it firmly during grinding or chiselling operations. When the lever is in the "off" position, the magnet's conductor bars and separators are so shifted that the magnetic flux completes its circuit by passing through sections of the top plate inserts without going through the work itself.

Beef Blood Powder in Hemophilia

A POWDER from beef blood which stops dangerous bleeding in hemophilia was reported by Drs. Frederick J. Pohle and F. H. L. Taylor, of Harvard Medical School and Boston City Hospital, at a meeting of the American Society for Clinical Investigation.

The ever-present danger to a person suffering from hemophilia is the fact that his

blood clots so slowly that he may bleed to death from a small cut. The condition is hereditary, affects only males, but is transmitted through the mother.

The powdered substance from beef blood checked bleeding from external wounds and following tooth extractions in five hemophilia sufferers, Drs. Pohle and Taylor reported. The substance itself is a protein called globulin and was obtained from the fluid, or plasma, of beef blood. It is effective only when applied as a powder to the bleeding surface. It failed to hasten the clotting of the hemophiliac's blood when given by mouth, or to stop bleeding when used locally in solution.

This life-saving material, the scientists pointed out, is not yet available in large enough amounts for general distribution.—Copyright, 1938, by *Science Service*.

CLIPPERS

IT is not so many years since everyone marveled at the construction of 20-ton airplanes. They have become commonplace. Now Igor Sikorsky predicts that it will not be long before there will be constructed 1000-ton flying clippers capable of carrying thousands of passengers.

ALUMINUM MOTION PICTURE FILM

OF particular value for educational and archive purposes is an aluminum motion picture film developed by the Fischer Film Corporation. This film, being opaque, must be projected by means of reflection, a principle which is well known and which gives good results both for picture projection and for the reproduction of sound tracks. Existing transparent negatives may be used for printing metal positives. Some of the advantages claimed for the new aluminum film are that it is not flammable and does not produce any gases, as is the case with certain standard Celluloid base films. Aluminum film is reported to be virtually indestructible; samples have been projected 1500 times without any perceptible wear. The metal film is permanent; there is no shrinkage and it never cracks or grows hard. It can be used in all climates from frigid to tropical, resisting dampness, mold, heat, and cold.

Because the film base is opaque, both sides may be used, thus cutting in half the number of feet of film required for a certain projection time. The cost is reported to be extremely low, not only because of the cheapness of the film base but also because of the fact that only 50 percent as much footage is required.

AUTOMATIC RADIO CONTROL

COMPLETE remote control—tuning, volume, and turning the set off and on—is one of the features of a new radio set called the Telematic, produced by E. H. Scott Radio Laboratories. By means of a small push button panel, the operator can select stations, turn the volume up or down,

Buttons on a small panel give complete remote control of a radio set

turn the set off or on, and can also control the built-in phonograph. Additional loudspeakers and keyboards can be placed in various rooms of the home and operated at differing volumes.

The set is also so arranged that it will automatically select a group of programs over a period of 24 hours, being pre-set by means of plugs for changing the tuning of the receiver as often as desired.

Insulation for Plating Racks

CORROSION of the racks on which metal parts are hung in an electroplating bath is a serious problem with platers. Not only is the destruction of the racks themselves expensive but impurities introduced into the bath are likely to be objectionable. A new synthetic resin product which will resist the corrosive action of solutions used in plating nickel, copper, zinc, silver, and cadmium even at the temperature of boiling, can be applied with a brush or by dipping. It provides not only protection against corrosion but also insulation against the electric current.—*D. H. K.*

Do Flies Shun Blue?

WHETHER or not flies—house, horse, or blue-bottle—have any artistic sense can be of little interest to anyone but the flies. However, the observation that flies appear to dislike and even to shun rooms painted blue is of immediate personal interest to everyone who has ever had to share his ice cream with *Musca domestica*, the common housefly. Although the literature on the life and habits of flies sheds little light on the subject, there appears to be a well-founded belief in many countries that flies are unhappy in the presence of blue, particularly a medium or "implement" blue.

While traveling in France, G. B. J. Athoe, an English architect, found that the walls of most of the hospitals and clinics there are painted blue for the purpose of discouraging flies. Both architects and physicians in France supported the theory that a light blue is disliked by flies and is an effective method of keeping the insects out of sickrooms. Pursuing the subject further, Mr. Athoe found that abattoirs and factories

built in Denmark by a distinguished Dutch engineer had bright blue interiors for the same purpose, a practice which the engineer had found successful in the kitchen of his own house.

A Frenchman some years ago conducted experiments on the color preference of flies, using a box, the walls of which were covered with squares of paper of various colors. Observations were carried on over a considerable period of time, and the box was turned in different positions in order to avoid error from other causes. After several days, a count of the flies in the box showed that 18 of the insects had chosen to rest on a clear green paper. The next largest number had chosen rose for their resting place, with clear yellow, azure, and clear red following in that order. Only one fly was found on the ultramarine blue. No conclusions were reached as to why flies chose azure blue rather than ultramarine.

As a result of his inquiries the English architect found that bright blue walls and ceilings have been found effective for keeping flies away in a number of English homes. One shrewd Englishman, suspecting that most flies enter the house via the kitchen, painted the walls and ceiling of that room powder blue, and found that this color barrier kept the rest of the house free of the flying pests. This practice is common in some South American countries and in parts of the West Indies where, in many instances, fly screens are not considered necessary when blue is used as a decoration.—*Technology Review.*

SPRINGS

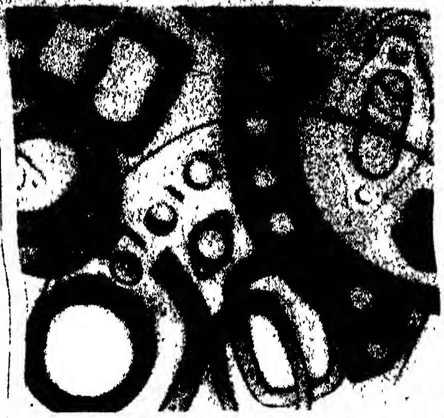
THE tiniest products of the steel industry are coil springs which weigh only 12 millionths of a pound each. Jewelers use them in necklace clasps.

Make Your Own Metal Gaskets

FOR the first time since the original gasket was used, it is now possible to make metal reinforced gaskets on the job, from any soft gasket material. The reinforcing is done with a channel-shaped, flexible strip of copper or other metal. This strip has serrated edges and pre-formed teeth and is fitted around gasket openings after the gasket has been cut. No special tools or skill are required. The teeth can be started, in most materials, with the fingers alone. The strip is cut from a coil as required, and ends may be either butted together or slightly overlapped. The flexible material is readily formed around sharp corners and irregular outlines.

When pressure is put on the gasket, the teeth are firmly imbedded and the material is completely metal clad at points where strength is needed the most. Any of the commonly used materials can thus be protected against pressure, corrosion, heat, or other factors that frequently cause rapid deterioration.

This strip, called "Bindedge," manufactured by the Azor Corporation, comes in 25 foot coils and three sizes, for binding material from 1/32 to ¼ of an inch thick. It



A variety of metal reinforced gaskets made with new binding material

is useful also for binding mounted maps, blue prints, drawings, and for protecting edges of many articles made from asbestos millboard, compressed or woven asbestos, fiber, felt, cardboard, paper, cork, rubber, fabric, lead.

Eye Test Defeats Fraud

A NEW eye test has been developed which will absolutely trap those who are fraudulently claiming damages for impaired sight in either eye.

According to Dr. J. F. Neumueller, director of American Optical Company's bureau of visual science, this new malingering test determines objectively, for the first time, the visual defectiveness of either eye without the person tested knowing which eye is under examination.

It is claimed this new test will have extensive use in professional and insurance offices for eye examinations and the detection of fraudulent or excessive claims for eye damages.

As explained by Dr. Neumueller, the test is dependent on the use of polarized light—rays that vibrate in one plane only. The test set consists of: (1) a spectacle frame containing two Polaroid lenses so inserted that the Polaroid axis in one is 45 degrees and 135 degrees in the other; and (2) a cross slide also equipped with a Polaroid disk which fits into a projector.

The polarized spectacles, the lenses of which look the same, are then placed on the person tested and he is asked to look through them at test letters projected on a screen. By manipulating a handle on the cross slide, the Polaroid axis may be changed from 45 degrees to 135 degrees, or vice versa.

When the axis in the slide is at right angles to the axis of one lens, the light coming from the projector through the slide lens will be completely polarized and the person tested will be unable to see the test letters with that eye.

By turning the handle, the axis of the slide can be altered so that it will be at right angles to the axis of the other lens and the person tested will be unable to see out of the other eye. This can be done without his realizing it.

In this manner, it can be quickly discovered whether he is shamming loss of sight in either eye since he is never aware with which eye he is seeing. In addition, the visual acuity of the malingering eye can be determined without his knowing it.

Conducted by JACOB DESCHIN

On Carrying a Camera

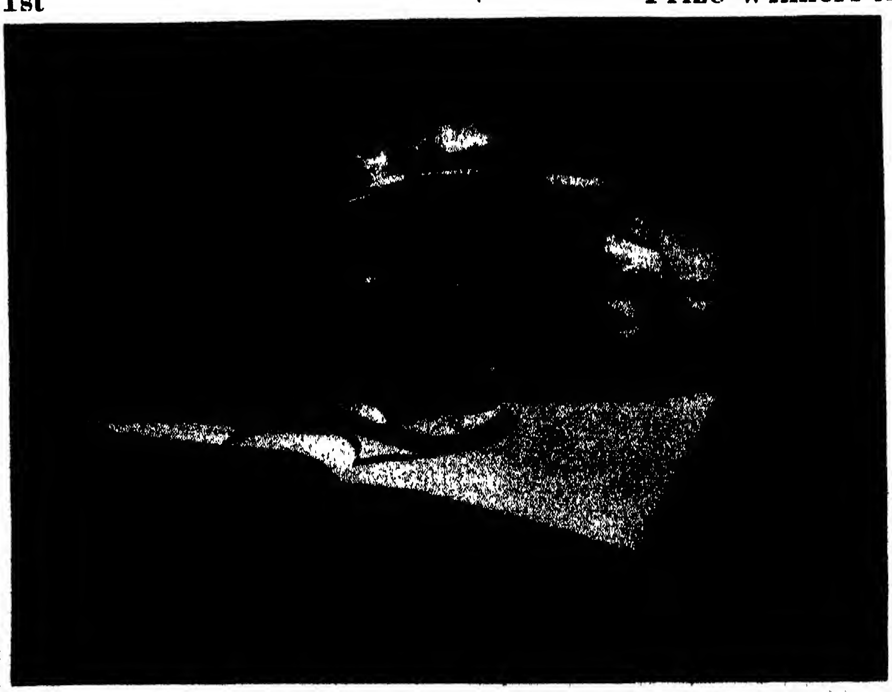
HOW do you carry your camera? Or perhaps you haven't given the matter any thought and simply stuffed your pocket (if you use a miniature) and went. If so, we suggest you mend your ways. It does not matter whether you paid much or little for your camera. The point is it's all you have and it's what you are using; therefore, you should give it every care and every attention.

Most persons generally agree that a camera should be carried in a case. Witness the great popularity of the ever-ready case, permitting as it does the use of the camera without removing it from the case. However, other camera users prefer to hold the camera itself, finding the case irksome for some reason. These latter, therefore, although they use a case of the ordinary type, often forget they have a case; after they once remove the camera in the course of a camera jaunt, they do not return it to the case until after the supply of film has been exhausted or they have decided to call it a day. This is a mistake. The camera should be returned to the case whenever there is a picture-taking interim of even short duration. Unforeseen accidents do happen and a camera that is dropped or banged when in a case will suffer but a fraction of the harm caused by a camera dropped without benefit and protection of a case. Of course, it is understood that the case you own or will purchase is well constructed and sturdy, with all edges and front strongly made to withstand hard knocks.

To minimize the danger of accidental knocks, some amateurs make it a practice to carry the camera case slung over one shoulder *inside* the coat. The coat prevents swinging of the camera and thus furnishes additional protection. Of course, this method is not convenient with the reflex types and larger cameras. In these instances it is suggested that the camera case (which we presume is carried suspended from the shoulder) be carried with the case shifted toward the front rather than the back of the body. This same method may, of course, be employed with the relatively "flat" types of cases.

Then there is the pouch type of case, usually a soft leather affair, that is carried in the coat pocket. This is fairly satisfactory if the camera is relatively light in weight, since the pocket of the coat provides the additional protection that is necessary. However, special care must be taken when carrying the camera in this manner to avoid accidental bangings. This type of

1st Prize Winners in



Calm, serene repose is ideally exemplified by this First Prize print submitted in our contest by Edward Canby of Dayton, Ohio. The photograph was taken with a Voigtlander Avus camera on 9 by 12 cm Agfa Superpan Portrait film

pouch is sometimes used for carrying small cameras "on the hip." This latter is certainly to be avoided, and for reasons of safety for the camera that it is not necessary to discuss here.

Carrying the camera slung from the neck and resting on the chest, with front of case opened and lens exposed without cap, is another of the don'ts. At least cover the lens if you *must* carry the camera in this way. Speaking of covering the lens, we make it a practice when working outdoors to keep the lens covered at all times when not actually shooting pictures, automatically uncovering the lens each time. And believe it or not, we have been doing this with one particular camera for about three or four years and haven't forgotten to remove the cap once. It's all a matter of habit; and it's a good habit.

The Miniature Camera's Rise to Fame

PHENOMENAL success always comes attended by questions as to the cause or causes that brought it about. And so it is with the miniature camera, which has inspired such questions as: "What do you believe is the reason for the meteoric rise to favor of the miniature camera?"

It is difficult to lay one's finger on any one cause or group of causes. One of the principal causes was probably the apparent inauguration of a new idea in photography, namely, that one could carry about one's person a diminutive camera which could be whipped out at a moment's notice to shoot a candid picture or stop a fleeting subject, and continue taking pictures to a total of 36 exposures before reloading. Another reason may have been the fact that, because of the fast lenses which could be used with these cameras, pictures could be taken in theaters, snapshots taken at night indoors and outdoors, and many other subjects attempted that had not been possible before.

But these are merely superficial causes; in themselves they are not sufficient reasons for a popularity that has lasted several years so far and bids fair to continue for some time to come. Photography as a hobby possesses a self-revitalizing force that will make it live forever; the miniature camera is but a spark that has set an old flame blazing anew. The miniature camera was born and survives not for itself alone but because of the many new applications it has introduced, because of the fresh and spirited viewpoints it has inspired.

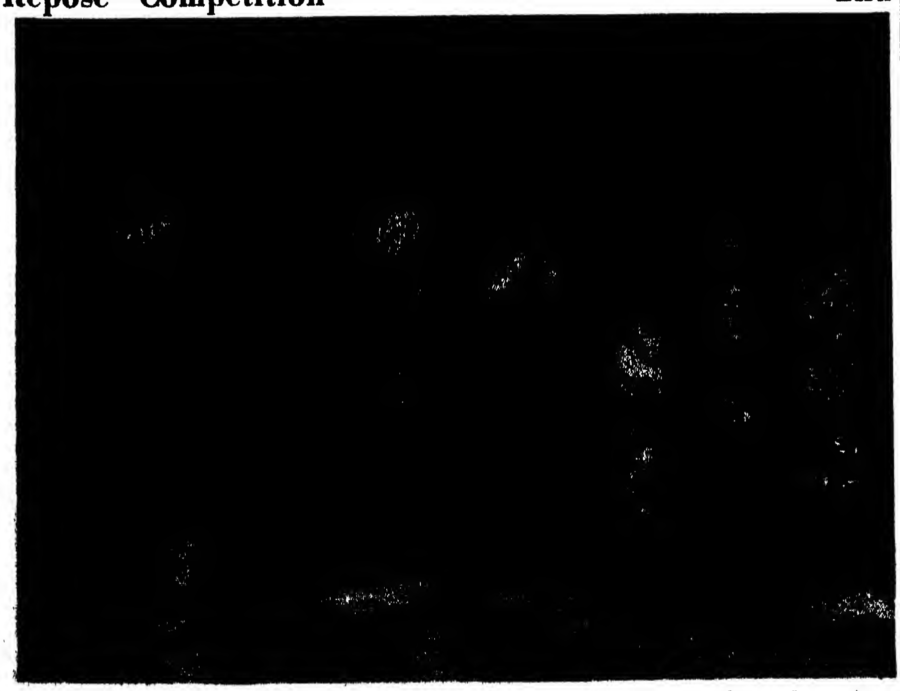
One of the chief contributions of the miniature camera has been in the technical and scientific fields where it has been of invaluable aid in recording the facts of science in a manner unequaled by any other method. Not only have records been made of facts known though not previously set down so graphically, but new facts have been uncovered and made indisputably true by the compelling proof of an image gathered by a lens and implanted on a sensitive film. This power of the miniature camera is being appreciated in various departments of science, industry, and exploration to such an extent that today we see a great and marvelously growing interest on the part of research workers in the use of this medium to aid them in their work.

All for Fine Grain

THE battle of the scientists for the ultimate in fine grain continues apace, a little inkling into the thoroughness with which this battle is waged having recently been afforded this department by the du Pont people.

"At the Redpath Laboratory at Parlin, New Jersey, where du Pont chemists are occupied in research on cameras and motion-picture films," they write us, "photographs with the microscope are found invaluable in the development of film itself—which there-

"Repose" Competition 2nd



Fine lighting and rendition of texture add to the repose theme of this Second Prize print submitted by Carlyle F. Trevelyan, Flushing, Long Island, New York. Taken with a Zeiss Ideal "A" camera on 2¼ by 3¼ Agfa Superpan film

by becomes an agent in the perfection of its own efficiency. Progressive enlargements of a negative from contact to 1000 times give a ready insight into the grain and clarity of the various experimental emulsions."

Now, who mentioned 15- and 20-diameter enlargements?

Natural Picture "Frames"

THE use of natural picture "frames" in photography was noted in this department some time ago in connection with the framing of a distant view by trees and branches in the foreground. Archways found in parks and public buildings provide other pictorial "framing devices" that furnish the answer to many a difficult problem in composition. As an example of this type of picture, we offer the accompanying illustration.

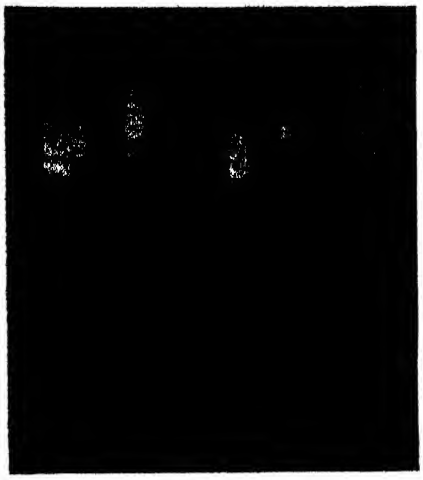
Through an archway

Substitute for Cotton

RECENTLY we had occasion to put to photographic use the familiar domestic accessory known as cleansing tissue, when our supply of cotton wadding was at zero just as we were getting down to some business of spotting glossy prints. You know, of course, that glossy prints may be spotted with pencil if the parts to be worked upon are previously treated to the retouching dope employed on negatives. A ball of cotton is ordinarily used to apply the dope and to rub it in. However, in the absence of cotton, we found the cleansing tissue was perfectly suited to the purpose and gave no trouble as to lint. As you know, the tissue is very soft and absolutely non-abrasive, making it ideal for photographic chores wherever it is desired to clean delicate surfaces, including the cleaning of the lens.

Baseball in the City

AS a picture describing an incident in a local baseball game, the sports editor would be fully justified in throwing this effort into the waste basket without a second glance. But we have a notion that the Feature Editor, looking for something to



"Baseball in the City"

illustrate recreation in the city, would feel more kindly disposed towards it. The spectators informally sitting about on the grass, the buildings in the distance and a baseball game in active progress—these are the elements which seem to us fairly accurately to picture a phase of city life on an off-day. Incidentally, don't you agree with us that the figures in the immediate foreground add immensely to the element of perspective in the picture?

Lady Candid Shooter

Her husband doesn't like the idea but Rosa Rolando Covarrubias, wife of the famous caricaturist, is a dyed-in-the-wool candid camera enthusiast willing to face even dangerous obstacles if the reward ahead is a batch of good shots. In a recent interview with Helen Worden, of *The New York World-Telegram*, she told of some of her adventures.

On one occasion, after an attempt to photograph an Arab chief in Tunis, who, she relates, "didn't like it because he thought I was taking his soul," Mrs. Covarrubias started using an angle view finder attachment, which permitted her to take pictures of subjects while apparently looking in another direction. Thus she was able to snap Singapore dancing girls in the native quarter, Mexican peons digging in Mayan ruins, and ceremonies in unexplored temples.

Lucky Encounter

Here's a lucky composition. The figure not only is placed in one of the "strong points" of the familiar rectangle but is firmly held there by the diagonal line created by the shadow of the fence. Had it not been

"Jest Restin'"

for this counter diagonal, the shadows of the tree branches and leaves on the sidewalk, the lighting of the chair and the restful attitude of the figure, the main diagonal, carried perfectly through by the chair, the shine box, the figure and the long shadow of the latter, might have seemed almost stark. As it is, the picture has warmth and atmosphere. Taken from the stairway of an Elevated Railway station with a 35-mm miniature camera, the picture furnishes one more proof of the benefits to be derived from making a habit of toting the camera with you whenever feasible.

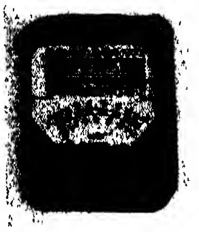
WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

A New Weston Meter

PROVIDING for 17 film speed ratings from 0.7 to 200 Weston, "meeting all present or future requirements of super-speed films," the "Weston Junior" ($15.50) makes its appearance on the market with a special dedication to the users of miniature cameras. The new meter employs the same type of photronic cell and sensitive instrument movement used in the Weston "Universal" and "Cine" models.



The new meter has a circular cell-window on one side, designed to cover a uniform angle of view, comparable with that covered by the normal camera lens. On the opposite side of the meter is a full vision dial. Thus, when the meter is held in viewing position, the user can take the readings while keeping an eye on the scene he plans to photograph. The dial lists 17 aperture stops from F:2 to F:32 and 27 shutter speed settings from 60 seconds to 1/1000th second.

Sensitivity of the new meter to low light values, the manufacturers report, is such as to provide readings where camera settings down to F:2 and ½th second are required on ordinary film.

Leica-Motor

THE Leica-Motor is being made available to permit Leica owners the facility of making several exposures in succession without rewinding. The device is so designed that successive exposures can be made at the rate of one or two per second, as desired, up to a total of 12, at a single winding of the fully enclosed spring motor.

This new Leica accessory is interchanged with the base-plate of the Leica and when attached to the latter the whole forms a compact unit. A key on the bottom of the Leica-Motor winds a powerful spring which enables up to 12 exposures to be made auto-

matically, release of the mechanism being accomplished by pressing a lever conveniently located on the front of this accessory. A scale on the Leica-Motor makes it possible to set it beforehand to make automatically the number of exposures wanted.

Abbey Flashgun

INCORPORATING a number of new features introduced to bring it into line with modern advances in photography, the Abbey Flashgun ($18.75) numbers among its advantages a six-inch parabolic reflector, chrome mirror finished and adjustable for all standard sizes of bulbs; miniature magnetic tripper so thin that it can be left on the lens board when the camera is closed; switch at bottom of battery case to facilitate quick release after focusing, switch and focusing knob being located "in the span of a hand;" built-in side lighting outlet; flush connector receptacles and new type flat connector with prongs molded in solid rubber.

"Handi-Slide"

CONSISTING of ready made glass projection slides bound in red Bakelite and copper, the "Handi-Slide" ($1.50 a dozen) is one of the latest devices for the users of 35-mm projection transparencies. In use, the transparency is merely enclosed between the two plates of polished glass. The plates are then bound in the Bakelite frame by a copper sheath, and the slide is ready for projection. The transparency may be quickly removed and a new one substituted.

The Peanut Superflash

A PEANUT-SIZE Superflash bulb, designated as No. 0 (16 cents), about 30 percent smaller than the smallest flash bulb made prior to its introduction—in fact no taller than a package of chewing gum—is now on the market. Its total light output, the manufacturers state, approximates 22,500 lumen seconds, more than enough illumination for open and shut shots with average films, as well as synchronized speed shots with faster films.

Also announced is "Special Press 40,000," only slightly larger than the standard Superflash No. 1. The press Superflash has a total light output of 40,000 lumen seconds, produced in a wide-peak flash of great intensity and power to penetrate distance and cover wide areas.

Focal Plane Shutter for Makina

SUPPLEMENTING the regular Compur shutter, with speeds up to the maximum of 1/200th second, normally furnished with the Plaubel Makina II and II-S, the makers have now introduced a special detachable focal plane shutter ($27.50) which is inserted in the back of the camera (close to the film plane) whenever very high speeds are required. The speeds of the focal plane shutter range from 1/100th to 1/1000th sec-

ond and one full turn of a knurled knob completes the winding of the shutter curtain.

This new accessory is attached to the back of the Makina in the same manner as the ground glass back, the film pack adapter, the film holders, and the automatic film-counting roll holder.

Coronet Vogue Candid Camera

INTRODUCED as a "flyweight" camera, the Coronet Vogue Candid Camera ($7.50) weighs only six ounces, is only 4½ by 2¾ by 1¼ inches in size, and produces pictures 2 by 1-3/16 inches (50 by 30 mm).

Streamlined, enclosed in a Bakelite body with chromium fittings, the Vogue is ready for action in an instant. The Coronet Vogue is equipped with an F:10 Every-Distance Lens, an Ever-Set instantaneous and bulb shutter, and brilliant direct vision view-finder.

Argus Speed Printer

MODERATE enlargements with the ease of contact printing is the principal feature of the Automatic Argus Speed Printer ($15.00), which makes 2¾ by 4¼-inch prints from 35-mm negatives directly, without focusing or trimming. Of modern design, the printer cabinet is all-metal, portable, weighs only 6¾ pounds and measures 7¾ inches high, 5¾ inches wide, 10½ inches long.

The Automatic Argus Speed Printer embodies a light source, a double condenser lens system, a double achromatic objective lens, and two first surface mirrors.

"Simply lay the ready-cut sensitized paper on the glass and press down the printer handle for a few seconds, which automatically makes the electrical contact and exposures"—this is the formula.

The manufacturers also announce the introduction of Argus Bromex paper, brought out specifically for use in the Argus Speed Printer, available in glossy, semi-matt, and silk surfaces and soft, medium, and hard contrasts, single weight and double weight. The single-weight papers come packed 36 sheets to a package while the double-weight papers come 24 sheets to a package (each 35 cents).

Foto-Flat Mounting System

CHARACTERIZED as a scientifically developed membrane (a thermo-plastic material) that will mount prints without pressure and with low heat, the Foto-Flat method of mounting prints is now available. The sheets are sold in various sizes from 1¼" strips for 35-mm prints to 16 by 20-inch sheets and rolls 16 inches wide by 100 feet long. (Dozen 5 by 7, 15 cents; dozen 8 by 10, 20 cents, and at relative cost in the larger sizes.)

The low heat of an ordinary electric iron will fuse the print to the mount in suitable fashion; however, a special device called the Foto-Welder (small size, $1.50; large, $6.50) is available that is thermostatically regulated to maintain the low heat required.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. Will you kindly tell me if there is a way to know when a desensitizer begins to work unsafely? Is there a mathematical rule to know the depth of focus of a lens at the different diaphragm openings, when we know the focal length of the lens?—Rev. R. T.

A. A desensitizer solution should last about six months if kept in a dark bottle. With use it will naturally oxidize gradually. One way to learn that the desensitizer is working unsafely is when films begin to show signs of fogging, but this may be due to using too much light; a safer way is to watch the color of the solution—when it grows lighter in tone, then it is time to mix a new solution.

For finding the depth of focus of a particular lens at various diaphragm openings, it is first necessary to learn the hyperfocal distance for the lens in question. Hyperfocal distance, which is the term applied to the nearest plane in focus when the lens is focused on infinity, is determined by the following simple formula: Multiply the focal length by itself; multiply the result by the circle of confusion (in your case, 1/250), the latter referring to the degree of unsharpness permissible because not perceived by the eye; divide the result by the F: value of the lens, say F:8, the latter multiplied by 12 to obtain a result in feet instead of inches. Thus, the square of 7.25 (focal length of your lens) multiplied by 250 equals 13,140; the F: number, 8, multiplied by 12, equals 96; 13,140 divided by 96 comes to 137 feet, the hyperfocal distance. Having obtained the hyperfocal distance, it is now possible to make up a depth of focus table for objects at given distances from the lens as follows: Multiply the hyperfocal distance by the distance focused upon. To learn the nearest point in focus, divide this result by the hyperfocal distance plus the focused distance; to learn the farthest point in focus, divide the result by the hyperfocal distance minus the focused distance.

Q. My camera is a Foth Derby with F:2.5 lens of 2-inch focal length. The focusing scale is marked in meters, as follows: 0.75, 1, 1.25, and so on. I have made up my own table in feet, as follows: 2½, 3, and 3½ feet, respectively. Is this correct? Also, will you please give me the depth of focus table for the following: Using stop F:2.5, distance focused upon 9 feet, 12, 21, 33 and infinity. Also, the table for F:3 and F:3.5 stops?—J. B.

A. Concerning your conversion of meter markings into feet, your first figure, namely, 2½ feet for 0.75 meter is correct, but the others are not. One foot is equivalent to 0.3048 meter. Therefore, one meter, as we figure it, comes to 3¼ feet, 1.25 meters to 4 feet, and so on down the line. As to the depth of focus (the correct term is depth of field) table, we suggest you consult our reply to Rev. R. T. above on the method of calculating near and far distances. By this formula, we find (figuring on a circle of confusion of 1/400) that 53.333 feet is the hyperfocal distance for your 2-inch lens wide open, namely F:2.5, and the near and far distances (in feet) in focus (depth of field) at the various distances focused upon, with the lens wide open, are as follows: 9 feet—near 7.7, far 10.8; 12 feet—near 9.8, far 15.4; 21 feet—near 15, far 34.6; 33 feet—near 20.4, far 86.5. As for infinity the nearest distance is, of course, the hyperfocal distance, namely, 53.333 feet. We understand that there is no F:3 marking on the lens in question. For the F:3.5 stop, the hyperfocal distance is 38.095 and the near and far distances for 9 feet are 7.3 and 11.8. With this, we leave you to carry through the rest of the calculations by yourself.

Q. In the handling of exposed film which has not yet been developed, if the fingers should accidentally touch the emulsion with no great pressure, is it likely that the latent image will be affected?—S. E. L.

A. If the fingers are perfectly dry, thoroughly clean, and no grit adheres to them, neither the film emulsion nor the latent image will be affected. However, this is not a good practice and should be avoided as much as possible inasmuch as the safety conditions prescribed seldom obtain. Hold the film by the edges is still the best rule to follow.

Q. Of what value are filters in freelance work? What effect can they have on the pictures?—J. S.

A. Because of your reference to freelance work and the wording of your first question, we presume that your second question refers to the possible effect that the use

of filters would have on the increased salability of pictures made with filters. Filters are designed for three purposes—to correct partially, to correct fully, and to over-correct. By "correction" we mean, of course, the use of a filter that, in conjunction with a suitable film emulsion, will produce a negative and an ultimate print or enlargement that will more or less faithfully represent the original subject. For this purpose the light and medium density filters are employed. Such filters are mandatory in much outdoor and some indoor work and the free-lance photographer must equip himself properly on this score, the selection of filters depending on the type of work he plans to do. On the "over-correction" side, the dark yellow filter will be found useful when photographing multi-colored objects, as in flower photography, while a red or orange filter as well as the dark yellow will help greatly in producing striking landscape pictures. The free-lance photographer must produce pictures that will sell and for that reason his work has to be considerably above the average in order to compete successfully with other commercial photographers. Filters will go a long way in producing pictures that will please the paying customers.

Q. I purchase my paper by the half gross. Can you suggest a method by which I can avoid wrapping and unwrapping the entire batch every time I need a sheet of paper?—L. A. S.

A. In the darkroom, by the usual printing light, slit one end of the heavy paper in which the photographic paper comes wrapped, and tear a small piece out of the center of this open end. This will permit you to take the sheets out of the package without unwrapping. Needless to add, one end of the box should remain sealed in order to serve as a "hinge" and the open end of the batch of paper placed at this end.

Q. What is a good method of removing abrasion marks from glossy prints? —N. D. O.

A. Dip a wad of cotton in alcohol and rub carefully over the affected parts.

Q. I have a supply of chloride paper that has been lying on the closet shelf for about three years past its expiration date. Do you think it is worth while keeping?—O. D. M.

A. Contact (chloride) papers are unusually stable and have much greater keeping qualities than the faster (bromide) enlarging papers. Try using the paper; it may surprise you to learn that it is practically as good as it was when you purchased it.

Q. Will you please send me any available material you have on founding a camera club in a high school?— K. T.

A. The details of founding a camera club are generally the same as those involved in starting any other type of club, except where it is planned to inaugurate a "community" darkroom and (or) studio for the use of the members. There are also the questions of how to defray the expenses of periodical exhibitions, sponsoring of prominent speakers, and so on. Several magazine articles have recently appeared which may furnish you with some ideas along this line by persons closely associated with this type of work. "Your Minicam Club" by Frank Liuni appeared in the January, 1938, issue of "Minicam," and the winter edition of "Everyday Photography" ran an article on "A Club's Club," while in the February-March issue of the same magazine there appeared an article by Bill Seaman on "Keeping a Camera Club Alive." Other expert sources of information on this subject are The Metropolitan Camera Club Council, 106 West 13th Street, New York, New York, and the Camera Club, West 68th Street and Broadway, New York, New York, one of the oldest camera clubs in the country.

Q. Photography has recently become so imbedded in me that I intend to make it my life's work. Knowing of your ability along this line, I would like your advice on getting a foothold in this profession. I'll appreciate any suggestions you may make.—B. R.

A. The first suggestion, and one which you must adopt immediately if you are to get anywhere at all, is to make up your mind as to the particular type of work you wish to undertake. Photography is a very general term including a multitude of different activities, all of which are classed as photographic endeavors. Presumably, you wish to go into one of the commercial branches of photography; but do you want to do studio work with models for advertisers, or turn out pictures for the press? In short, it is necessary to specialize in some one branch of photography because each presents its peculiar problems and methods. We presume, of course, that you already have some knowledge of photography and are seeking a "foothold," as you express it, in order to apply your knowledge to best advantage.

Q. In photographing a waterfall I have tried unsuccessfully to avoid the "white paper" effect. Can you suggest a method of photographing a waterfall so it will look natural?—L. D.

A. Instead of giving the subject one full exposure for the time required, place the camera on a tripod and give several shorter exposures totaling up to the time required.

Q. How many films (No. 120) can be developed in one quart of the Eastman D-76 formula without increasing the development time? What increase in development time would you suggest, if it is possible to get good results in this way, after this number of films has been developed? The only difference between the Eastman formula F-5 for films, and F-1 for papers, is that the former contains 15 grams of boric acid. Would it make any difference in tone or keeping qualities if F-5 is used for paper or F-1 for films? Which of the two is better for use on both?—J. G. P.

A. About 10 rolls is the maximum number generally recommended, with an increase of about one minute in developing time for each roll processed thereafter. Formula F-5 was introduced as a fixing bath in film processing because it was found to improve the contrast in negatives. Paper, however, is not sufficiently sensitive to gain anything in this regard, and for this reason it is pointless to use F-5 in fixing prints. However, if you wish to use the same formula for both papers and negatives, we suggest F-5 for the sake of the negatives.

Books

SELECTED BY THE EDITORS

BRASSEY'S NAVAL ANNUAL 1938

Edited by Rear-Admiral H. G. Thursfield

MORE has happened in connection with naval questions throughout the world during the past year than during any similar period for many years. With the new enlarged naval programs there will be even greater activity during this year. This 49th Edition of an old authority discusses the activities of the past year and serves to indicate the trend not only in amount of building but in design. As usual there are pertinent discussions as to the international situation, relative naval strengths, trends in design in various countries, aviation and its place in the naval scheme, and a chapter on the transatlantic air service. There is a large reference section on all types of armament, and as usual the book is well illustrated with scores of photographs, silhouettes, battleship plans and elevations. (521 pages, 6½ by 9¾.)—$12.50 postpaid.—*F. D. M.*

BRILLIANCE—GRADATION—SHARPNESS WITH THE MINIATURE CAMERA

By Harry Champlin

WHAT is the difference between an ordinary print turned out by a run-of-the-mill photographer and a superlative print of salon quality that immediately commands both attention and respect? According to the author, the difference lies mainly in those refinements of technique which all too few photographers will take the trouble to learn. In this fact is found the reason for the preparation of the present book in which are concentrated those aspects of technique in which the majority of miniature camera workers are weak. (160 pages, 5½ by 8 inches, numerous photographs and a few drawings and tabulations.)—$2.15 postpaid.—*A. P. P.*

LEGENDS OF GEMS

By Horace L. Thomson

THE author's earlier little book, "Gems How to Know and Cut Them," now forms the second and minor portion of a new and larger book, the newer portion being on amulets, astrological birthstones, and on gems in their mystical or occult connections all the way from Aquarius to Capricorn! In it the author says, "There is more to the science of stellar influence in human affairs than is generally realized . . . before long the vibrations of gems and their powers will be better understood." This reviewer does not "understand" these "powers" but still recommends the older, non-occult and practical part of this book to gem-stone hobbyists who do not object to the pseudo-science of astrology. (124 pages, 6 by 9 inches, illustrated.)—$1.15 postpaid.—*A. G. I.*

THE ENGINEER'S SKETCH-BOOK OF MECHANICAL MOVEMENTS

By Thomas Walter Barber

TO use a hackneyed expression, this volume is a mine of information for the designing engineer, for it contains discussions and working drawings of practically every conceivable movement, device, appliance, and contrivance employed in the design and construction of machinery for every purpose. The illustrations, in fact, total nearly 3000 and everything is classified and arranged for easy reference. It is intended as a guide to enable the engineer to solve any mechanical design problem visually. (355 pages, 6 by 9.)—$4.45 postpaid.—*F. D. M.*

TELEVISION A STRUGGLE FOR POWER

By Frank Waldrop and Joseph Borkin

TELEVISION is foreseen by the authors of this book as a power for good—or for evil; they appear to lean toward the evil side. They take the view that, just as the automobile replaced the horse, television will revolutionize all world standards of living. They may be right and, in any event, it does no harm to consider all the aspects of a coming scientific development. They assume that television is here. It is, in the laboratory. How soon it will invade the average home and just how effective it will be in supplementing or outmoding other forms of communication is still a problem which many authorities would hesitate to answer in as definite a manner as have the authors of this book. Good reading, whether or not you agree with the conclusions drawn. (300 pages, 6 by 8½ inches, unillustrated.)—$2.90 postpaid.—*A. P. P.*

SAFETY FIRST AND LAST

By Charles E. Dull

AUTOMOBILES are, in reality, powerful projectiles in the hands of people who have not been thoroughly schooled in their use. This book attempts to show proper use, so that the driver of each car may have reasonable assurance that he will not get himself into so tight a place that he cannot safely get out. The first 156 pages discuss driver problems in detail and show by drawings the proper way of passing on the road or at corners, parking, and navigating some of the odd by-pass intersections that have been constructed. It has also a much needed discussion of the car itself so that the driver may understand its capabilities. The last part of the book concerns safety in the home, on the farm, and in the factory and tells how to avoid such injuries as are commonly caused by use of ladders, fire, and electricity. The conclusion states that accidents *can be checked* and shows how it is up to you and me to solve this problem. (241 pages, 5¾ by 8½.)—$1.90 postpaid.—*F. D. M.*

BATTLES WITH MONSTERS OF THE SEA

By F. A. Mitchell-Hedges

NARRATIVE accounts of tussles with large jewfish, tiger-sharks and other sharks, queenfish, giant crawfishes, colossal turtles, eagle-rays, barracudas, tarpon, alligators, saw-fish, and numerous others. Slaughter, shock, horror, jungle of the sea, the "clutching death" (octopus), fight, fury, man-eater, adventure—such words chosen at random give the keynote of this book, in which a British sportsman tells of his searchings for excitement. He found it and put it into this book. Lively reading!—$4.20 postpaid.—*A. G. I.*

FIRST AID FOR THE AILING HOUSE

By Roger B. Whitman

ENTHUSIASTICALLY received by home owners everywhere in its first edition, this latest revision, enlarged and expanded in many of its aspects, should be even more widely acclaimed. It gives the latest information on oil burners and air-conditioning equipment, house insulation and plumbing, paints and enamels, and many other topics too numerous to mention, yet definitely indicated by the title of the book. (350 pages, 6 by 8½ inches, a sprinkling of drawings.)—$2.65 postpaid.—*A. P. P.*

KNOWING YOUR TREES

By G. H. Collingwood

FIFTY common trees of the United States—common but not commonly known—are discussed in this well illustrated book, which is a reprint of monthly features that have been running for some time in the magazine *American Forests*. Each tree is discussed in a single spread of two pages with one prominent picture of a typical tree of the type named, a photograph of the foliage or fruit, a photograph of the characteristic trunk, and a drawing of the United States showing by shaded sections the natural range of the tree in question. (109 pages, 8¾ by 11¾.)—$1.15 postpaid.—*F. D. M.*

SHEET METAL WORK

By William Neubecker, Instructor, N. Y. Trade School

A MANUAL of Practical Self-instruction in the art of pattern drafting and construction work in light- and heavy-gage metal, including skylights, roofing, cornice work, patterns for forced-air fittings, and so on. The treatment assumes that the reader already knows how to use tinsmithing tools. (360 pages, 5½ by 8 inches, 400 illustrations.)—$2.65 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Uniquely, the richest-field telescope, or RFT, because of its special design, reveals in one view of splendor the greatest number of stars that can be made visible in any telescope, small or large, and the man who first worked it out, S. L. Walkden, of London, described its principles in "Amateur Telescope Making—Advanced," with a follow-up article in the present columns last January. In the following paragraphs he now proposes an RFT Cassegrainian.

"There is a proportion of keen designers and constructors always on the lookout for 'new worlds to conquer', to whom old-fashioned simplicity and ease of construction make an inadequate appeal, and some of these feel an exhilarating urge to pass over ordinary reflectors and wrestle with the troubles of Cassegrainian and newer types. They undoubtedly have hard and adventurous jobs before them, but these are precisely what they want.

"So, first, regarding the aperture, a inches, of an ordinary Cass RFT: If this is less than 4", the convex and the hole are likely to rob the main mirror of more than 20 percent of the light, and that is rather too much compared with the 9 percent of the 4" Newtonian. If, on the other hand, the aperture exceeds 11", the constructor may need an eyepiece more than about 3" in diameter. This really should not be allowed to matter, but 3" is about the limit of what some seem to like or think practicable in ordinary instruments.

"Having settled the aperture, a inches, the mirror's focal length is made c times a inches, where c is the focal ratio. It is advisable to have c equal to about 4; for, if c is greater, the area of mirror put out of action by obstruction and by the hole is unduly increased, while if c is less the mirror and the convex are not easy to make of a quality to give good definition.

"With a and c both settled, and so of course with $F=ca$ inches (Figure 1), the proper distance of the convex within the primary focal point, or the distance d, is found from $d= F(\sqrt{20F}-2F/a)\ /\ (10a-2F/a)$ inches. Then $2r$, the diameter of the convex and of the hole in the main mirror, is given by $2r=F(F-d)\ /\ 5ad$ inches.

"The focal length of the convex, or f, is given by $f=d\ (F-d)\ /\ (F-2d)$ inches, though perhaps a 5 percent error in making it, especially 5 percent less, need not be worried about.

As to the eyepiece, it is to be made identical with one which would suit a plain refractor RFT of focal length equaling the F" of the main mirror, but of aperture equaling only $2r$, the inches diameter of the *convex* mirror. Its particulars may then be arranged by methods like that outlined in 'ATMA,' but the extra diameter of the field lens, mentioned at the end of the footnote on page 633 and amounting to $F/50d^2$ inches (where a is *now and here* the diameter of the convex) may not have to be considered 'negligible'. The eye distance, too, may often be rather larger, at about $1\frac{1}{4}\times(F/14a+F/17a^2)$ inches, where the convex diameter is again inserted for a, as the '*virtual* aperture' in the Cass *eyepiece* calculations.

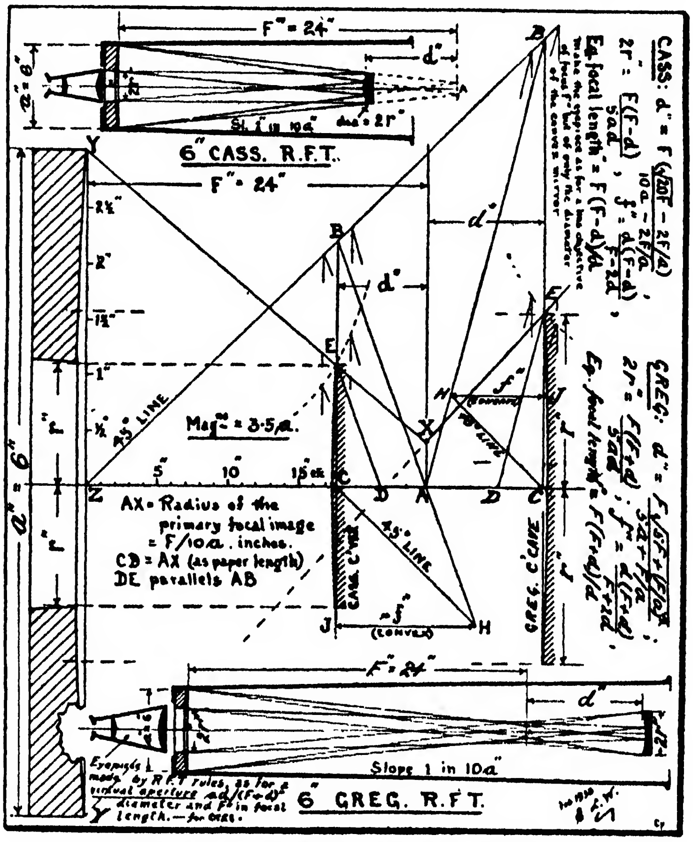


Figure 1: **Layouts for RFT Cass and Greg**

"There is an alternative graphical way of solving these problems of the Cass RFT, and it sometimes has advantages over mere inflexible formulas, and nearly always helps. It is illustrated in Figure 1, in its application to a 6" aperture of 24" focal length, for which, of course, $c=24/6=4$. The method is as follows: From Z draw ZA horizontally, equal, to scale, to the 24" focal length of the main mirror. Again from Z draw ZY vertically, equal, to a much larger scale, to the 3" radius of the mirror. Then from A draw AX equal, on the same larger vertical scale, to the radius of the main focal RFT image, or to $F/10a$, which in this case is 24/60, or 0.4". Join XY, to tell the needed radius of the convex mirror for any distance d within the main focal point. From Z draw the 45° line shown. Now from A draw the 'triangular spiral' $ABCDE$ (by a little easy trial and error), having CD exactly equal to AX and DE exactly parallel to AB, and having its finishing point E on CB and *also* exactly on the line XY.

"Then we have found at C the proper place for the convex mirror, 17.6" from the main mirror; and in CE we have found the proper radius of the convex mirror, 1.10", and of the resultant field image, 1.10", and of the hole to be made in the main mirror, 1.10"—and, within about ⅛", the larger radius of the field lens of the eyepiece. As to the focal length, f, of the convex mirror, by drawing a 45° line from C till it joins BA produced in H, and noticing how far H is horizontally and to scale to the right of C, the focal length needed, or f, is found to be 10.12"; and that is 10.12/2.20, or 4.60, times the convex's diameter.

"Making the eyepiece according to the settled rules, as for a 2.2" refractor of 24" focal length, the field lens is 2.4" diameter. The eye lens may be ¾ of that, or 1¾", but will suit if not less than 1.4". The lenses' distance apart, the usual $c/4$—that is, $F/4a$ inches—is 2¾", and the eye distance will be about 1.4" according to the formula before given.

"It might be asked: 'Why not design the convex an inch or more farther from the main mirror, and so have the convex only 0.99" or less in radius?' The answer of the triangular spiral is that the resultant field image like CE, and therefore the hole in the main mirror, would swell up to 1.37" or more in radius (see the dotted curve through E), so that no advantage could be reaped. Then, it may be oppositely asked: 'Why not design the convex an inch or more *nearer* the main mirror, and so have the resultant field image and hole only 0.90" or less in radius (see the dotted curve through E)?' The answer of the XY line is that the obstructive convex needed would itself swell up to 1.21" or more in radius, so that again no advantage could be reaped.

"The only real remedy both ways is to have a *very short* main focal length, say 9", so as to have a delightfully small convex and hole, and the whole instrument as small and portable as a silk hat; but, at the present day, such short-focus remedy is more easily spoken about than put into practice, especially seeing that the convex needs to be similarly shortened in focal length and be formed like too much of the end of an egg.

"It is useful to notice that this graphical method equally well solves the problem of *any* ordinary Cass of 40° fully illuminated

apparent field, even if not an RFT, provided we draw AX, the radius of the primary field image, 0.35 F/pa inches long, where p is the lowest power per inch of aperture which it is proposed to use.

"To the right of point A in Figure 1 is drawn the similar graphical solution for the corresponding 6" Gregorian RFT, if only to show how unsuitable this type seems to be for RFT construction, for it should be noticed how large the concave mirror and the hole have to be. For this reason and because the diagram is similarly lettered to the Cass diagram (using slanting capitals), detail description is unnecessary; moreover, the chief formulas are written at the right of the drawing. In the Gregorian the eyepiece has to be arranged the same as for a common refractor RFT, of focal length equaling the F" of the main mirror but of virtual aperture assumed to be only $ad/(F+d)$ inches diameter.

"At the top of the diagram is drawn, entirely to the horizontal scale, the sectional arrangement of the 6" Cassegrain RFT, which certainly has the virtue of shortness; and at the bottom of the diagram is drawn to the same scale the 6" Gregorian RFT, which certainly has more than the one defect of length. But, whatever defects either is here seen to have as described, these defects may easily be the longed-for challenges to the clever and energetic and further-discovering constructors before referred to, each acting on his belief that difficulties are only made to be met with and be triumphed over. So far as there is success there is again the reward, of the richest and loveliest views of the heavens yet seen by man, using the given apertures."

As Kirkham showed here last month, the very simple RFT calls for a better-than-simple eyepiece—ideally an achromatized and costly Ramsden but at least a plain but very good Ramsden. However, when the market was canvassed it turned out that there was no wholly suitable eyepiece to be had if the rather ideal specifications—f.l. 1.12", .92" diam. field lens, as in "ATMA," 636—were considered. However, one dealer is making up a special lot having approximately these specifications. At the same time comes a letter from Walkden containing his own impressions regarding eyepieces for RFTs. First, he says: "If a telescopist thinks of employing a certain eyepiece of stated focal length f", he should pay great regard to the caution in 'ATMA,' page 645, footnote 5, making quite sure, as by test, that he knows the *actual* focal length f" of the eyepiece." In this he is quite right for, as Ellison has pointed out, many eyepieces differ quite widely from the focal length designated on them. He then continues: "Now the RFT is really a simple telescope of the lowest possible power of about 3.5 per inch of aperture, and its proper, *fully illuminated* apparent field of view is considered to be about 40°, as obtainable by a usual type of Ramsden eyepiece. From all this there follow certain consequences, one of which is that the field lens of the suitable eyepiece of f" focal length should have approximately the diameter of $0.70 \times f$ inches and, indeed, could be about 1/10" larger than that, because the lens is a little on this side of the field image. If the field lens is much smaller than that, the apparent field of view is likely to be correspondingly less than 40° in diameter,

and even then have the stars rather dim toward the margin of the field. The fault closely resembles that of the too-high-powered Galilean field-glass or telescope with small eyepiece.

"The diameter of the field lens being satisfactory, the eyelens' diameter should be about one quarter less. Though 0.6 times the diameter of the field lens is not in every case too small, it is usually a little in doubt. On no account should the eyelens fail to be a good deal wider than 0.3″, since that is about the width of the pupil of the eye.

"The eye-hole should be 0.4″ to 0.5″ in diameter and be at a proper distance from the eyelens, but those things are easily enough set right in the completed instrument.

"Speaking generally, RFT eyepieces are confined to the range of 1″ to 5″ *f.l.* Ramsdens of about 1¼″ *f.l.* are called for chiefly by the Newtonian RFTs of moderate apertures. Ramsdens of about 1¾″ *f.l.* are called for by the small, short refractor RFTs. Ramsdens of about 2½″ *f.l.* can convert the moderate length refractors into RFTs, and Ramsdens of about 3½″ *f.l.* can convert the ordinary *long* refractors into RFTs. The Ramsdens of 2½″ to 4″ *f.l.* can also help to complete Herschelian RFTs of moderate apertures, to which variety of RFT too little attention has hitherto been given." [Later we shall publish Walkden's specifications for several Herschelian RFTs, calling for eyepieces with field lens diameters all the way up to *five full inches!* Needless to say, no reasonable telescope maker can ask dealers to stock all these freak eyepieces—if, indeed, he stocks any that are larger than about 1.14″, so the would-be owner will probably have to take off his coat and maybe his shirt and make his own gill, pint, and quart eyepieces.—*Ed.*]

Continuing with regard to ordinary and medium sized RFT eyepieces, Walkden adds: "In all these cases the main focal length F″ of aperture a″, *made to suit the eyepiece*, is given by $F = 3.5 \times a \times f$ inches, just as $f = 0.286 \times F/a$ inches, and $F/f = 3.5\ a$; and for the Newtonians, an eyepiece focal length within about 15 percent of that of the table on page 636 of 'ATMA,' with the flat recalculated to suit the mirror and its actual focal length F″, will not result in any material increase in the flat obstruction. In effect, it evidently interests some correspondents that $a = 0.286 \times F/f$, and, indeed, that a is not greater than $0.285 \times F/f$ inches, where 'not greater than' stands for '*cannot be used greater* by the human eye than,' due to anatomical limitations."

SOMEONE—amateur, dealer or manufacturer—ought perhaps to canvass carefully the question whether it would not be profitable to put on the market, not for telescope makers or necessarily for real amateur astronomers alone, but for a larger market among that part of the public which has a less scientific but more emotional interest in astronomy, a compact, fool-proof RFT, probably a refractor, designed with studied care on the basis of the fixed anatomical and optical optimums stated in the chapter on the RFT in "ATMA" and in the January 1938 Scientific American. The American people are known to be especially susceptible to "mosts"—things that are the most this and the most that—and the RFT, showing as it does the most stars it is possible for any human being to see at one view, not even excluding a view with a 200″ telescope, ought easily to be dramatized and caused to be desired by far more than the few hundred dyed-in-the-wool amateur telescope makers who are dealing with it now.

LAST month Alan R. Kirkham showed in these columns that the old, conventional Cassegrainian telescope, with its hyperbolical secondary which was diabolical to figure, can be supplanted by a spherical secondary Cass with elliptical primary, which will be far less of a headache to make. A copy of Kirkham's article was sent to Walkden and in an immediate reply the latter points out that Kirkham's spherical secondary Cass also kills another bird, making practicable at last the short RFT Cass. The Cassegrainian, he points out, can beat the Newtonian RFT in illumination only by being very short, but this has previously meant figuring hyperboloidally, with much difficulty, that "end of an egg" mentioned above in his article. Now, however, with a merely spherical end-of-an-egg needed, we may go the whole hog, and Figure 2, redrawn from a rough sketch sent hurriedly by Walkden, is one example. One trouble with this stubby, chubby, and intriguing little Cass might be that, in the poor light of night, the owner's neighbors might think, as they watched him holding it aloft against the skyline, that he was tipping up a large bottle of some liquid, and might come to wonder about "this astronomy." "Altogether," Walkden writes, "many thanks are due to Kirkham for this well-timed help that places the amusingly short Cass RFT quite on the map."

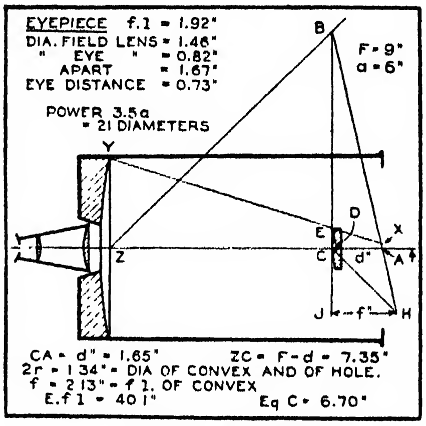


Figure 2: **One-gallon RFT Cass**

Credit for putting back on earth the spherical secondary Cassegrainian idea, which appears to have been described years ago but so far as is now known was never actually embodied in a telescope at that time, is shared by Kirkham and Dall, as mentioned last month. We discover that the little Cassegrainian shown on page 447 of "ATM" was Dall's first spherical secondary Cass. In the February 1932 Scientific American, where the same photograph first appeared, Dall described it as a "modified Cassegrainian."

WAX coating laps, Everest's method: "My method was to draw strips of tissue paper through smoking hot beeswax, cut these into squares after cooling, scrub the dry pitch lap with a clean rag slightly moistened with turps, lay the squares on the facets of the lap (channeled in the regular

manner), and roll them down with a rubber roller in order to eliminate air pockets. However, I have discarded wax coating for figuring precision surfaces. It gives a beautiful *visual* polish, free from sleeks and scratches, but I have never seen the optical qualities in wax-polished surfaces that I have been able to produce with plain pitch. HCF is several times faster than plain wax, so I prefer to use it to produce a perfect *visual* preliminary polish and then take the necessary care to preserve this visual polish while figuring on pure pitch."

We occasionally hear from workers who complain that HCF leaves its marks on the figure. It does; but, as has often been pointed out, Everest does not recommend HCF for figuring ("ATM," 4th edition, page 149). For this he uses pitch, and states that the HCF marks disappear in about 20 minutes.

Everest makes his own pitch. Formerly he used the old rosin-turpentine mixture but found that laps made of this soon became "case hardened." To remove this shell the turpentine rag was used. The immediate effect of this was great stickiness. This disappeared some 24 hours later, after the surplus turps had evaporated off. From then on, and lasting a week or so, the lap worked splendidly until the turps had evaporated, when case-hardening became evident again and the same cycle had to be repeated. It now appears that turpentine in laps may be one of those blunders which have been perpetrated for years for the simple reason that someone back in the Dark Ages started the procedure—just as with the hyperboloidal secondary Cassegrain. Everest learned that castor oil would go into perfect solution with melted rosin and that the resulting mixture would be stable since the oil does not evaporate. "And we now make our pitch of rosin," he states. "It is first boiled hard to remove all traces of natural solvent and then is tempered with castor oil."

ON August sixth, which is a Saturday, the Thirteenth Annual Convention of amateur telescope makers from everywhere will be held at *Stellafane*, near Springfield, Vermont. Any person having an interest in telescopes is welcome. People begin arriving late Saturday morning, the afternoon is taken up with mutual and informal conversation, also with the examination of telescopes (bring your own), and there is a dinner at six, for which a dinner price is charged. Following this there are speeches for about two hours and then more informal "visiting." The majority leave during the evening but a few enthusiasts stay the night to use the telescopes. Those who remain meet Sunday morning for breakfast and by noon all are flown home. It all provides a fine chance to meet and talk with other "folks." Feminine family members can escape from telescoptical boredom by talking with other non-telescoptical family members who always come. It's a combination of convention, sewing circle, old home week and a three-ring circus. Places to camp if you wish to camp. Plenty of parking space. R. J. Lyon, 252 Summer St., Springfield, Vt., is the Secretary.

TO obtain data for compiling a relative rating of the general opinion regarding telescope supply dealers, the editor invites all readers to give confidential reports based on their experiences, good or otherwise. Please name the dealers.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

Shoe Constructions, by Roy C. Bowker, contains brief descriptions of 40 individual shoe constructions and discusses their classification under eight main classes. The circular also discusses the value to the customer of marking shoes to show the type of construction, and touches upon the subject of shoe performance. Circular of the National Bureau of Standards C419. *Superintendent of Documents, Government Printing Office, Washington, D. C.—10 cents (coin).*

The End of Reflected Glare in Light is a pamphlet that describes in detail Polaroid lighting, its principle and advantages. Drawings show just what takes place when light is reflected from a reading surface. *Write for Bulletin 738A, Scientific American, 24 West 40th Street, New York City.—3 cents.*

Action Snapshots, by H. Starke, is a 48-page illustrated booklet which shows the amateur photographer the best ways for taking action snapshots under the many conditions that will be encountered in the course of a day's photography. Beautifully reproduced photographs show the results of perfectly exposed negatives. *American Photographic Publishing Company, 428 Newbury Street, Boston, Massachusetts.—50 cents.*

Quit Your Skidding is the title of a 32-page booklet which shows in detail the effect of tire treads on automobile skidding. It also gives valuable hints as to what to do to avoid skidding and—equally important—what to do when the car does skid. *Write for Bulletin 738B, Scientific American, 24 West 40th Street, New York City.—3 cents.*

Butterflies of Colorado, by Frank Clay Cross, lists 241 species of butterflies to be found in that state and is accompanied by several halftone illustrations. Volume XVI, No. 1, Proceedings of the Colorado Museum of Natural History. *Colorado Museum of Natural History, Denver, Colorado.—25 cents.*

The Neoprene Notebook is a periodical devoted to the uses of Neoprene, a "synthetic rubber." It is of particular interest to engineers and industrialists who have occasion to make use of materials of this type. A request for this periodical will place your name on a mailing list to receive every issue as published. *Write for Bulletin 738C, Scientific American, 24 West 40th Street, New York City.—3 cents.*

Anniversary Bulletin of the Western Precipitation Corporation gives some of the historical background of dust and fume control in industry, particularly in the field of electrical precipitation of suspended particles. It also tells of present work along these lines, presenting numerous photographs of modern equipment for the purpose. *Western Precipitation Corporation, 405 Lexington Avenue, New York City.—Gratis.*

Photographic Almanac gives valuable suggestions on how, when, and where to make pictures. It includes a handy exposure table, a guide to correct exposure, hints for better pictures, and the latest developments in photographic equipment. 128 pages. *Write for Bulletin 738D, Scientific American, 24 West 40th Street, New York City.—3 cents.*

The Uses of Minerals is an unillustrated brochure that lists alphabetically those minerals which are of the greatest value to industry and the arts, devoting a short paragraph to the general characteristics and uses of each. *W. Scott Lewis, 2500 North Beachwood Drive, Hollywood, California.—15 cents.*

Practical Radio Mathematics, by M. N. Beitman, is a booklet designed specifically for home study. It pre-supposes only a working knowledge of arithmetic and elementary algebra, attempting to clarify some points of elementary mathematics and to interconnect such knowledge with radio and allied applications. Illustrated with diagrams and charts. *Write for Bulletin 738E, Scientific American, 24 West 40th Street, New York City.—50 cents.*

Negative Films for Use in Miniature Cameras is a 16-page pocket-size pamphlet which describes the characteristics of five different emulsions of 35-mm films. Exposure and processing data are given, including formulas for developers and fixing solutions. A tabulation of filter factors is included, covering 30 different types of filters. *Write for Bulletin 738F to Scientific American, 24 West 40th Street, New York City.—3 cents.*

Accident Prevention in the Bell System, by W. P. Elstun, is an 18-page illustrated booklet that tells not only of the safety equipment used but also of employee training and the establishment of incentives for safety. *Bell Telephone Laboratories, Inc., 463 West Street, New York City.—Limited free distribution.*

Aviation Radio Log contains valuable information for professional and sportsman pilots. In 132 pages it presents data for planning flights and for instrument flying. It also tells about aircraft radio, radio-compass flying, obtaining true bearings of broadcast stations, and gives a list of such stations together with their call letters and frequencies. A limited number of copies are available. *Aviation Radio Section, RCA Manufacturing Company, Camden, New Jersey.—25 cents.*

Beer and Brewing in America, by Warren M. Persons, is a study of the economic aspects of the brewing industry. The historical side and the development of brewing are discussed, together with production and consumption, taxation, benefits to allied industries, and so on. *United Brewers Industrial Foundation, 21 East 40th Street, New York City.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

HYBRID PATENTS

ORDINARILY, a patentee cannot describe an article of manufacture in a patent claim by the method of making the article.

There are four types of subject matter which may be protected by patents; namely, machines, articles of manufacture, methods, and compositions of matter. In a patent for an article of manufacture the claims should identify the article by describing the characteristics of the article. In exceptional cases, where it is impossible to define an article of manufacture by its characteristics, it is permissible to define the article in the claims by the method of making it.

In a recent case before the Court of Customs and Patent Appeals an inventor had filed a patent application for a method of cooking meat and the product or article resulting from the method. One of the claims described the resulting meat product by the method of making it and the Patent Office tribunals rejected this claim on the grounds that the article should be defined by its characteristics and not by the method of producing it. The Court reversed the Patent Office tribunals however, and found that the product could not be defined by its characteristics and could only be defined by the process of producing it. In this connection the Court stated the law relating to this subject as follows:

"If it cannot be otherwise defined, and it is new and inventive, a product may be claimed by the process of producing it."

ONE MINUTE

THE words "One Minute" are not descriptive of a washing machine, according to the Court of Customs and Patent Appeals.

A washing machine manufacturer sought to register as a trade mark for his product the words "One Minute." The Patent Office held that the words were either descriptive or mis-descriptive of a characteristic of the washing machine and refused to register the mark. In support of its ruling the Patent Office contended that the words "One Minute" indicated the speed of operation of the machine and that a prospective purchaser would believe that the machine would wash clothes in that time.

The Court of Customs and Patent Appeals decided contrary to the Patent Office and stated that the mark was neither descriptive nor mis-descriptive but was fanciful and arbitrary. The Court found that no washing machine could wash clothes in one minute and that the name "One Minute" would not mislead or deceive prospective purchasers of the machine. The essence of the Court's decision is to be found in the following quotation:

"Appellant's mark is clearly not descriptive of its goods. Is it mis-descriptive, and, therefore, deceptive? Would a purchaser, on seeing the trade-mark 'One Minute' on one of appellant's washing machines, be misled into believing that such machine would wash clothes properly in one minute? We think not."

MAL AMI

THE owners of the well-known trade mark "Bon Ami" for soap have successfully opposed the registration of the trade mark "Shav-ami" for shaving cream. The case was recently decided by the Court of Customs and Patent Appeals and the basis of the Court's decision was that the concurrent use of the two trade marks was likely to cause confusion.

The Court found that the manufacturer of the shaving cream used the trade mark "Shav-ami" from May 16, 1932, while the soap manufacturer had used the trade mark "Bon Ami" for many years prior to any use by applicant. The shaving cream manufacturer emphasized the difference between the goods and between the first syllables of the trade marks. The Court found, however, that the word "Ami" was the dominant part of the trademark and that variation of the first syllable would not, *per se*, avoid confusion. In reaching its conclusion the Court stated:

"It is true that there is a difference in the marks and a difference in the goods, but it seems to us that, since the mark 'Bon Ami' is for a product of everyday use which is widely known, and is unusual in its arbitrary character, confusion will be more likely to occur than under other circumstances. 'Bon Ami' means 'good friend'. The appellee uses the same word 'ami', pronounces it 'ah-mē', and pronounces the whole word 'shav-ah-mē'."

LEGAL MORALITY

THE publisher of one of the innumerable sex-inspired magazines brought suit against the publisher of a competing magazine, charging unfair competition in simulating both the name and contents of the magazine. The Court carefully considered the contents of both of the magazines and pointed out that something more than unfair competition was involved. The stories and pictures in both magazines were suggestive, if not obscene, and the Court held that under the circumstances a Court of Equity would not intervene to aid either party.

In reaching its decision the Court stated:

"The Court has no power to stop the publication of magazines of this type, in a civil proceeding, but neither will it lend itself to granting to one the sole right to publish such filth. Nor will it grant either magazine a cloak of respectability by issuing an injunction. These magazines can have no useful place in the world of literature, and the very selection of the names is indicative of the fact that the publishers' sole desire is a financial return for the dumping of obscene and filthy publications at a cheap price where the young, immature, and impressionable people can buy."

BOOKS AND THINGS

IN a recent suit the plaintiff, who was the owner of a circulating library, sought to restrain a former employee from soliciting, canvassing, and distributing books to plaintiff's customers. The plaintiff's business was conducted through the medium of route men who rented books to plaintiff's customers for 25 cents a week. The defendant was formerly employed by plaintiff as a route man and had been given a list of 450 customers. Proof was submitted that some of the customers had been solicited and that nine of plaintiff's customers were now dealing with the defendant. The Court found that defendant had not signed a contract with the plaintiff and that after severing his employment with the plaintiff he had a perfect right to solicit his customers. In this connection the Court stated:

"The defendant, upon the severance of his employment, had the undoubted right to compete in a fair manner with his former employer and to use any knowledge acquired by him in so doing so long as he violated no confidence. Mere solicitation does not constitute unfair competition in the absence of an express agreement to the contrary."

COLLYRIUM

FOR many years a manufacturer of an eye lotion designated its product by the name "Collyrium." Within recent years a competing manufacturer used the same name in connection with its eye lotion and contended that it had a perfect right to do so because the name "Collyrium" is generic and signifies an eye lotion or salve. The question of the respective rights of the parties came before the New York State Supreme Court and the Court found that Collyrium was an English word meaning eye lotion or salve but that it was not a common word and was seldom used outside of professional circles. It found also that due to the long, exclusive use of the mark "Collyrium" by the first manufacturer the word had acquired a secondary meaning and indicated to the public the product of the first manufacturer. In reaching its decision the Court stated:

"The word 'Collyrium' can scarcely be included in even the broadest category of common or usual words ***. It is not a word of common English speech. It may with absolute propriety be catalogued with words capable of acquiring by long usage a secondary meaning when used in connection with a given product."

SCIENTIFIC AMERICAN ADVERTISERS
July · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York
ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 159, No. 1, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • AUGUST • 1938

OF vast importance to mechanical engineers is the study of the "creep" of steel and metal alloys. In order to accumulate data on this subject, new furnaces have been designed to test metals under conditions of temperature reproducing those in actual service. The furnaces are described in detail on page 84 of this issue; a close-up of one of them is presented on our cover.

18985

The SCIENTIFIC AMERICAN DIGEST

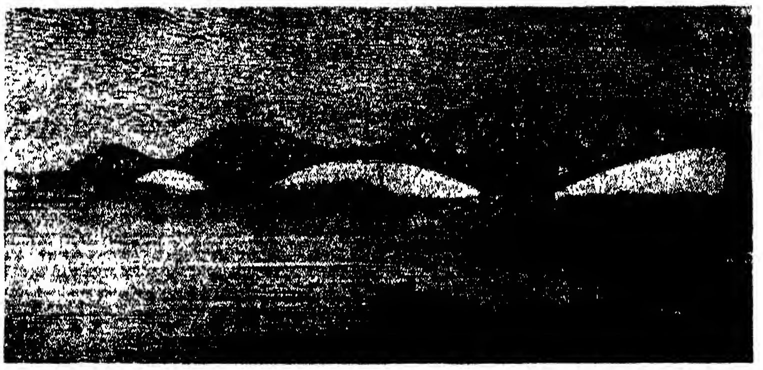
SCIENTIFIC AMERICAN, August, 1938. Vol. No. 159, No. 2, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1888)

FORTH BRIDGE—"We give . . . a sketch of the Forth Bridge, showing it as it will appear when finished. . . . The great work is now approaching completion. This remarkable structure is situated at Queen's Ferry, about ten miles from Edinburgh. It crosses the Forth, an arm of the North Sea. We are apt to think that the great suspension bridge between New York and Brooklyn is a work of great size, but it is rather small when compared with the Forth Bridge. The latter has two main spans, each 1,710 feet in length, which is 114½ feet longer than the span of the Brooklyn Bridge. The three main towers of the Forth Bridge are 375 feet high. The total length of the bridge is 8,084 feet. The bridge is built on the cantilever system, of steel, of which there will be about 42,000 tons used in the superstructure."



MARS—"The observations of M. Perrotin at Nice, and M. Terby at Louvain, and, in England, of Mr. Denning at Bristol, have confirmed the presence on the planet of most of the 'canals,' or narrow dark lines, which were discovered by M. Schiaparelli in 1877, and at subsequent oppositions."

BALLOONS—"Captive balloons are to be employed at sea during the next stage of maneuvers by the Toulon evolutionary squadron, under Vice-Admiral Amet."

STRAIGHT—"The new Argentine Pacific Railroad from Buenos Aires to the foot of the Andes has on it what is probably the longest tangent in the world. This is 340 kilometers (211 miles) without a curve. In this distance there is not a single bridge and no opening larger than an ordinary culvert, no cut greater than one meter in depth, and no fill of height exceeding one meter."

ANTI-FOULING—"The Japanese Admiralty has finally decided upon coating the bottoms of all their ships with a material closely akin to the lacquer to which we are so much accustomed as a specialty of Japanese furniture work. . . . Experiments . . . have resulted in affording proof that the new coating material remains fully efficient for three years and . . . completely withstands the fouling influences so common in tropical waters."

MICE—"The mouse pest in Australia is much worse than the rabbit pest. The climate is so soft that they have thrived enormously, and there is said to be hardly a residence or store that is not pestered by the plague . . . while from every side come tales of crops devoured so rapidly that many fields have had to be abandoned, what was left not being worth reaping."

Q AND A—"How many miles of railway in the United States? One hundred and fifty thousand six hundred miles—about half the mileage of the world. How much have they cost? Nine billion dollars. How many people are employed by them? More than a million. How long does a steel rail last with average wear? About eighteen years. What is the cost of a palace sleeping car? About $15,000, or $17,000 if 'vestibuled.' What is the cost of a high-class eight-wheeled passenger locomotive? About $8,500."

ECLIPSE—"Four thousand blanketed Comanches, Kiowas, Cheyennes, Arapahoe, and Delawares were at the Anakee agency to get their rations when the recent total eclipse of the moon occurred. The savages were greatly excited. The principal chief ordered them to shoot at the 'evil thing,' and the force of Indians opened fire in the air, keeping up the shooting for upward of an hour, and until they were out of ammunition. When the moon appeared in view after the eclipse, wild whoops went up for what they believed to be their victory."

PLASTIC—"Poteline is the name of a mixture of gelatine, glycerine, and tannin, to which sulphate of barium, or of zinc, may be added, and which may be colored by vegetable colors. It may be kneaded while warm. When cold it may be used for numerous purposes. It can be turned, filed, bored, polished, and can be used for hermetically sealing bottles, etc. The proportion of ingredients varies according to the uses. For sealing bottles, of course, it must be used liquid."

GAS MASKS—"There was recently an exhibition . . . of Loeb's appliances which are designed to enable the wearer to breathe and work with comfort in dense smoke, and also in poisonous gases. The device consists of a respirator with an india-rubber mouthpiece. The air is drawn in by the wearer through a series of small filters, containing, respectively, wet sponge, cotton wool, cotton wool damped with glycerine, and animal charcoal."

COLD—"Dr. Hann gives an interesting account of the winter temperature of Werchojansk (Siberia), deduced from several years' observations. . . . Monthly means of —58 degrees F. occur even in December, a mean temperature which has been observed nowhere else in the polar regions; and minima of —76 degrees are usual for the three winter months (December-February) . . . while in January 1885, the temperature of —89 degrees was recorded."

OHM—"M. H. Wuilleumier has recently made a redetermination of the true value of the ohm, using Lippmann's method. He concludes from his experiments that its value is the resistance of a column of mercury of a square millimeter section, 106.27 centimeters long, this result being practically the same as that obtained by Lord Rayleigh and others."

AND NOW FOR THE FUTURE

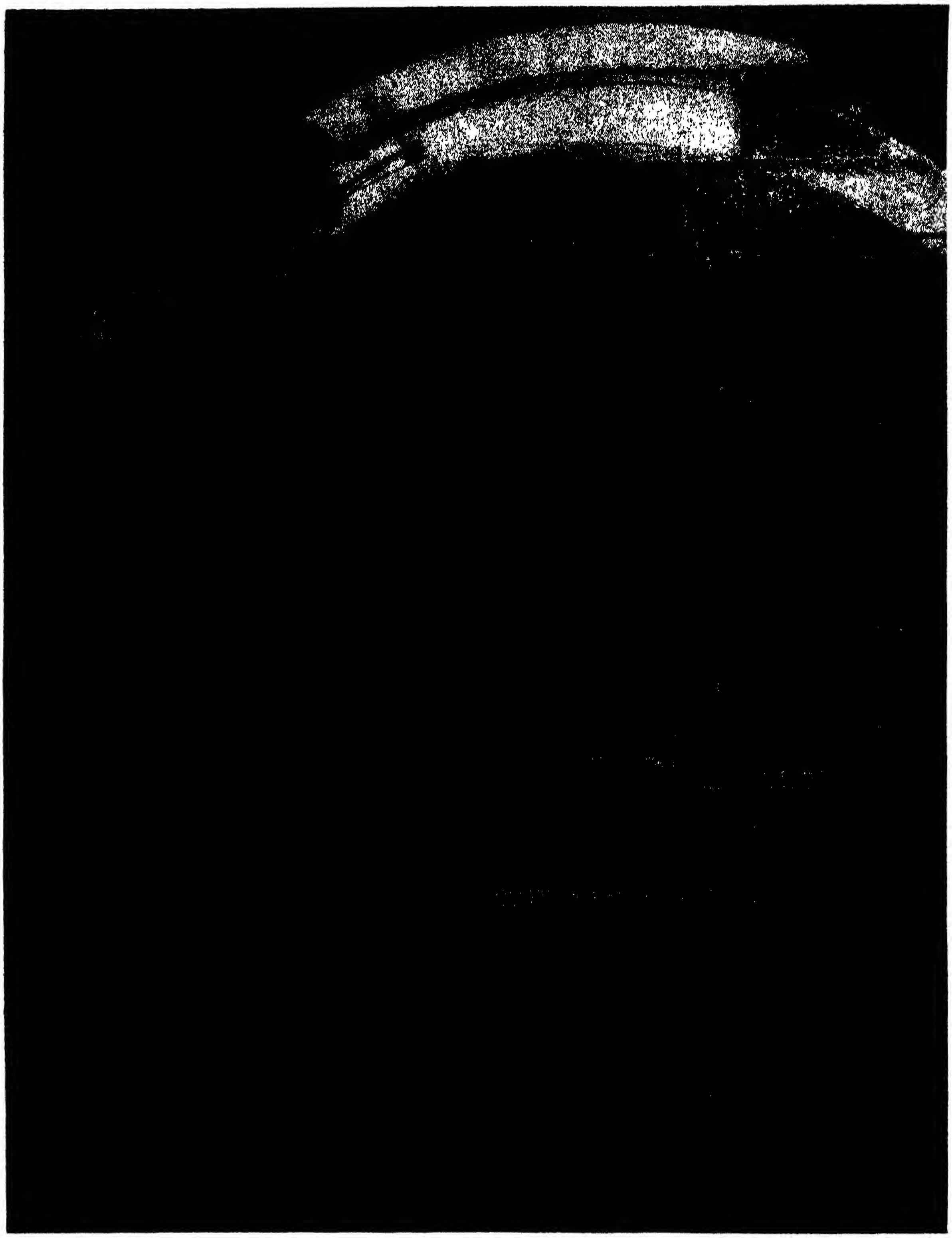
¶Wall-board—an industry built on waste, by Philip H. Smith.

¶Diesels make a place for themselves in aircraft power-plants, by Paul H. Wilkinson.

¶New international bridge is an unusual engineering project, by D. B. Steinman.

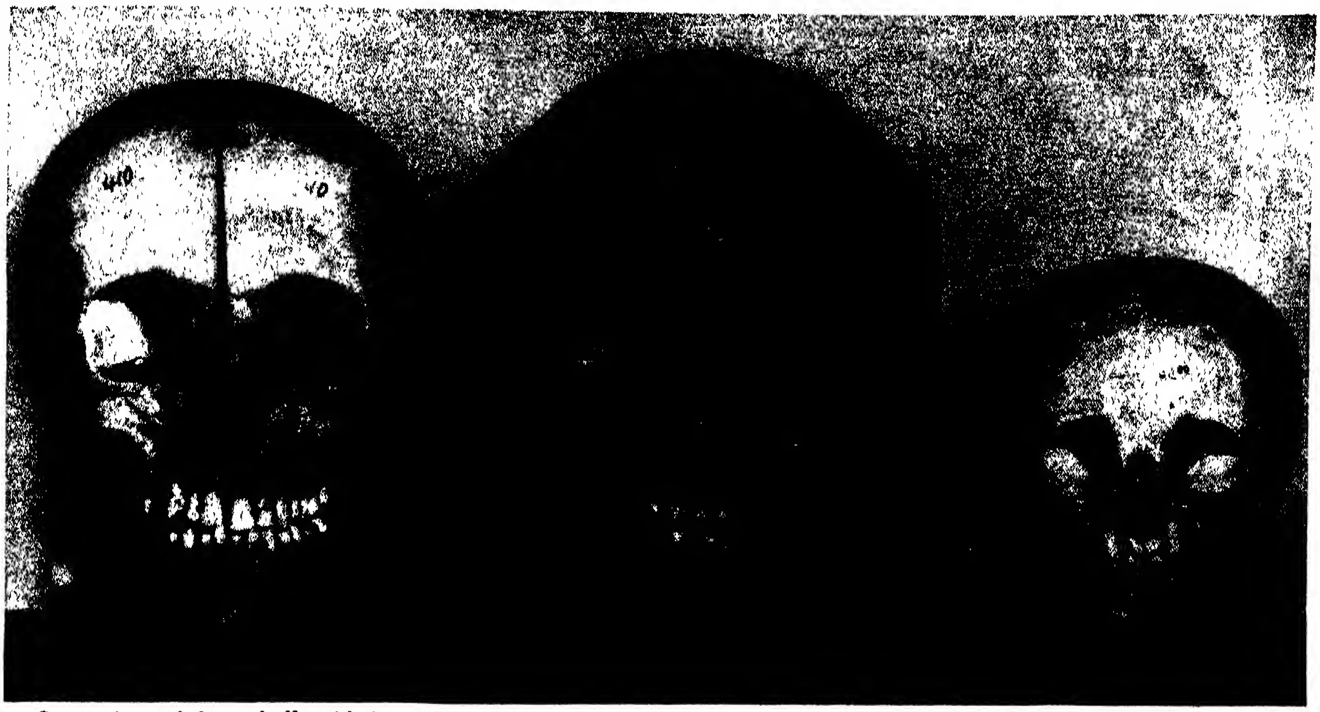
¶Lessons learned from the centuries-old vegetarian diet of the Chinese, by William H. Adolph.

¶Making new atoms in the laboratory by artificial transmutation, by E. U. Condon.



AN UNPRECEDENTEDLY LARGE PIECE OF FINE MECHANISM

HOW gigantic will be the 200-inch telescope now within but two years of completion in California is revealed by the scale of the three human figures in Russell W. Porter's drawing shown above—so small in comparison that they are even difficult to find. But only after reading the article on page 68, and especially after minutely studying each of the five illustrations, will the reader come to sense how complex a mechanism this instrument has been to design. In size, as a mechanism, it is unusual; in complexity, likewise; in precision—that of a refined watch, though it outweighs 5,000,000 watches. When these three are compounded it is phenomenal.



Comparison of three skulls with features that are obvious to the layman. On the left is the typical skull of an adult white male, aged 18. Its size and proportions are those of a man who grew up. *In the center:* Skull of white male, aged 18, who merely grew —of infantile proportions and contour. *At right:* Skull of an infant, aged about one year, of infantile size and proportions

THE SKELETON TALKS

Bones of Skeleton Give Amazing Data . . . Tell Age, Race, Sex, Stature, and so on . . . Study Is Important in Anthropology. Archeology, and Criminology

By WILTON MARION KROGMAN
Associate Professor, Anatomy and Physical Anthropology, Western Reserve University

WHOEVER said "Dead men tell no tales" certainly didn't figure on the physical anthropologist who makes it his business to interpret and translate the tales that dead men *do* tell. Give him merely a few skeletal fragments—a thigh-bone or part of a skull —and this trained scientist will construct a story complete almost beyond imagination.

Suppose we take as an illustration the following, and not unusual, example of "skeleton analysis." Some children playing in a ditch discovered several bones of a human being. After studying these skeletal remains, the anthropologist produced a full-length anatomical portrait of the person to whom the bones had belonged. She had been, the analysis disclosed, a female mulatto, 33 years old, 5 feet 6½ inches tall and had weighed about 120 pounds. These clues led to the identification of a missing colored woman, whose physical measurements were on file with the police at the time of her disappearance. Observe, now, the close agreement between the anthropologist's conclusions and the actual facts. According to police records, the deceased had been half-negro, half-white, 33½ years old, 5 feet 7 inches in height and had weighed 125 pounds!

This startling accuracy is no fluke, no random thrust at probability. The skeleton of a human being, alive or dead, reveals infallibly that person's physical history and will continue to do so for centuries beyond the grave. Race, sex, age, stature, serious illnesses, and sometimes the cause of death are recorded permanently in skull, pelvis, and the "long" bones of the arms and legs. The method is so accurate that today it is of primary importance to the criminologist, the historian, and the archeologist. It is even applied to the living skeleton by means of X rays as a valuable check on growth and health.

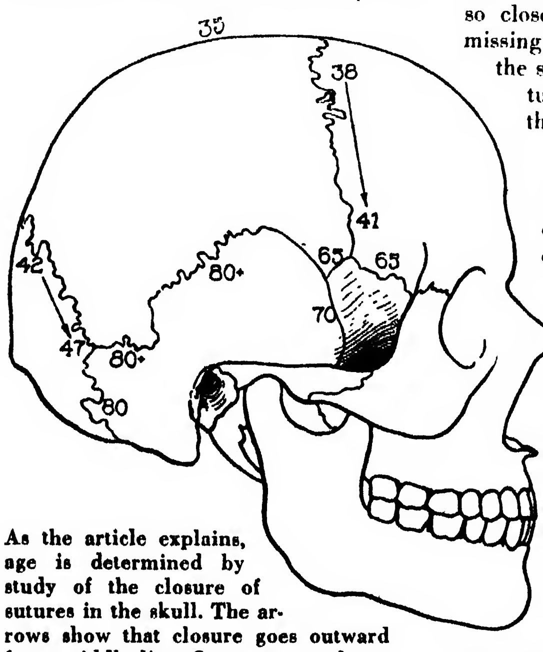
THE skeleton yields up its secrets principally through accurate comparative measurements. Racial characteristics, for example, show clearly in the proportions of the skeletal elements. Thus, Negro skulls are long and flat; the eye sockets are wide apart, and the facial plane slants strongly. The pelvis is narrow and the arm bones are very long in proportion to the legs. These elements are quite different in the white race. The anthropologist not only identifies each type with ease but, if the subject is not "pure," can usually determine the exact degree of intermixture of the two.

Sex shows itself plainly in the general proportions of the bones of a skeleton, whether still alive or dead for thousands of years. A skull alone will determine sex in nine out of ten cases, while the pelvis will do it 98 percent of the time. The two together give *positive* identification. The female skull capacity is some 200 cubic centimeters less than that of the male; the eyebrow ridges and mastoids are less prominent. Woman's pelvic bone is much wider and her whole skeleton finer and more graceful. The male frame is robust and massive and the bones are more rugged.

The scientific bone-detective computes the stature of a dead man by mathematical formulas based on the lengths of arm and leg bones. The thigh bone is the most useful for this purpose. Statis-

tics show that the height of a man will be 1.88 times the length of this bone, plus 813.06 millimeters. In a female, the stature is 1.945 times the length of the thigh bone, plus 728.44 millimeters. Similar formulas apply to the upper arm-bone and shin-bone, and give results *closer than 1 percent* to the actual stature!

These formulas may be applied to the whole anthropological panorama from the Ice Age down. The Neanderthal Man of 100,000 years ago, for example, was only five feet four inches tall, while Cro-Magnon Man 75,000 years later had achieved a full six feet. Shortly after that an adverse environment must have overtaken him, for he dropped back to five feet seven inches. On the other hand the famous Pitcairn Islanders, who had ideal genetic conditions in their remote retreat, soon produced a type taller than either their white or Polynesian forebears. Today, the younger generation in America is taller than its parents and the parents, in turn, top the generation behind them. All of this is divulged by an exact study of the major bones which for nearly a million years have been recording the height of man above the ground.



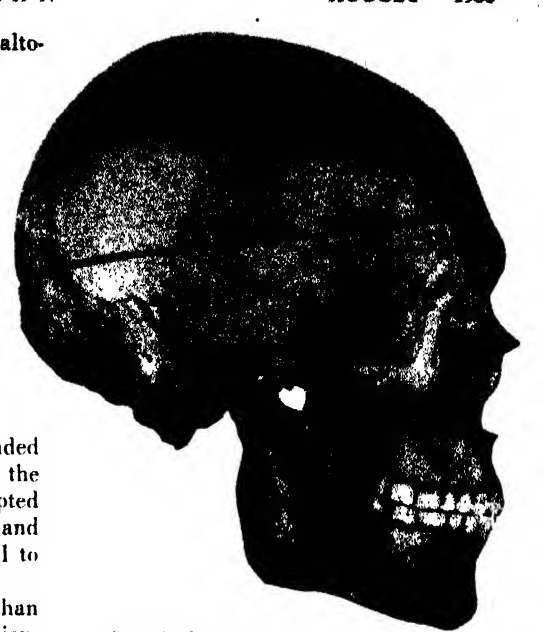
As the article explains, age is determined by study of the closure of sutures in the skull. The arrows show that closure goes outward from middle line. Sutures around ear-hole close after 65 years or not at all

A SCIENTIST'S ability to determine the *race* of a skeleton meant a fortune in oil to a half-breed Indian in Oklahoma not long ago. The half-breed's son had disappeared several years before, at the age of 18, leaving behind him a tract of land on which oil was later discovered. The father's claim to his son's royalties was contested because it could not be proved that the boy was dead. Meanwhile various other claimants appeared and the Indian was in danger of losing his fortune altogether.

It was known that a youth answering the boy's general description had been killed riding a freight in nearby Arkansas, and before settling the case the court ordered the body exhumed and studied. After three days in the laboratory, the anthropologists were able to establish that the skeleton had belonged to a half-breed Negro-Indian male, about five feet seven inches tall, midway between the ages of 18 and 19. Other bone measurements corresponded so closely with the description of the missing youth that the court accepted the scientists' proof of his death and turned over the fortune in oil to the father.

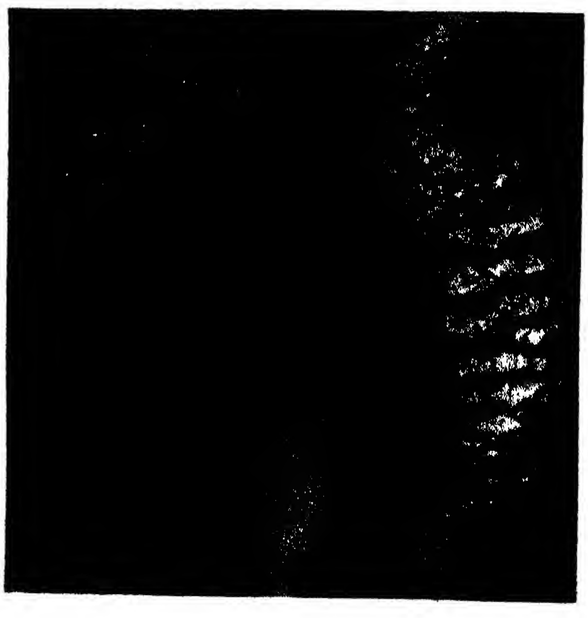
We know more about age than any single item of identification. Methods of determining it are complex but are amazingly accurate. All the long bones grow from maturation areas, or "centers," by the addition of calcium and other materials. This process is known as the "appearance and development of centers of ossification." From birth to five years of age, these centers appear in order; they almost literally punch a time clock and register their owner's age. From five to 12 years these centers grow in size. From 12 to 21 years, they unite with each other. By noting the various aspects of these centers, it is possible to determine the age of anyone under 21 years, within two or three months.

After 21 we must look for other age-changes—particularly in the skull. The 23 bones of the skull are separated by divisions called "sutures." As age advances, these sutures disappear one after the other, according to a rigorous schedule. The three sutures on top of the head, for instance, begin to fuse in a certain order, the first at 22 years, the second at 24, and the third at 26. They are completely erased, in the same order at 35, 42 and 47, respectively. During this quarter century the degree of elimination of the sutures reveals the subject's age usually within a year or less.

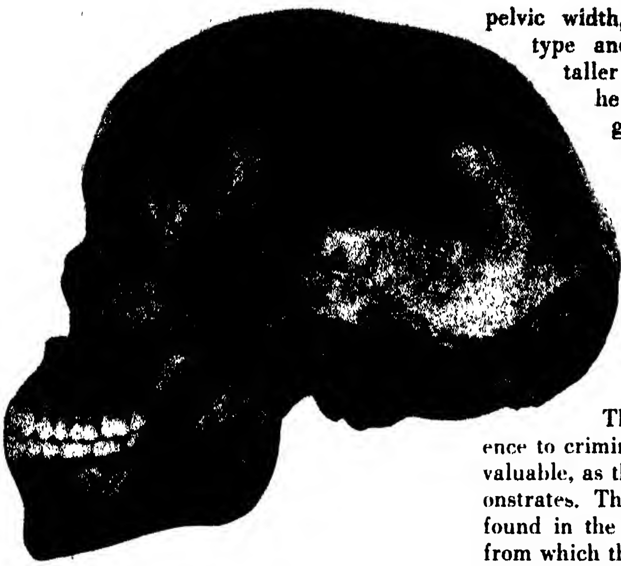


A typical white profile for comparison with that of a Negro, opposite. It is the skull of a white male, aged 21 years. The vault is high arched, there is but a slight slant, if any, in the face, and the two eye sockets are set relatively close together

The texture of the bones is another guide to age. After 30, the flat bones, such as the shoulder-blade and brim of the pelvis, begin to lose their blood-supply. As a result, they become dry and brittle; sometimes they warp and shrink. The long bones develop roughened areas at their ends; these areas are called "pseudo-arthritic," for they close-



The texture of bones changes steadily with age. For example, this pubic symphysis may be compared with the one opposite. This one is of a white male, aged 18 years, and shows the characteristic "ridge and valley" appearance of an immature, poorly outlined surface



By contrast to the white man's skull, opposite, this Negro skull is long, has a prominent occiput, and a lower, rather flat, vault. The facial profile slants obliquely forward and downward, providing the foundation for the Negro's typical face

ly resemble the bone-changes in rheumatism and arthritis. And either way the bones creak in old age.

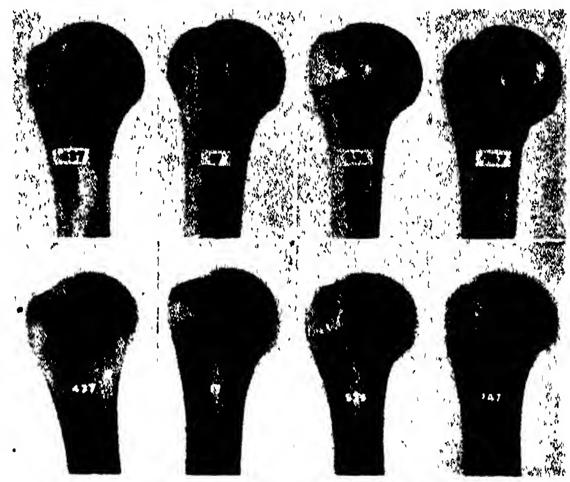
These characteristics remain intact even after thousands of years in the tomb. The age of the famous King Tutankhamen was accurately read from his skeleton to be about 18 years, and of his father-in-law, buried nearby, only 30. The two were also found to be blood relations, for their bones bore a close family resemblance. These facts helped Egyptologists in completing the picture of that ancient dynasty; thus the physical anthropologist often fills in a historic gap that cannot be closed in any other way.

How about weight and build? These questions are answered by the knowledge that the dimensions of stature and pelvic width, generally indicate body type and weight. Obviously, the taller a person and the broader he is across the hips, the greater his weight. But this is not so exact, for avoirdupois *does* have the annoying habit of disregarding the skeletal framework. Sometimes the weight guess is good, sometimes poor. In general, it is the least satisfactory of the anthropologist's findings.

The applications of this science to criminology are self-evident and valuable, as the following example demonstrates. The skeleton of a man was found in the charred remains of a car from which the number plates had been removed. Murder was suspected. A man had recently disappeared in the vicinity after receiving threatening letters. The skeleton was minus a leg, which had apparently been burned away, but to make the matter more complicated, a wooden-legged man of the same age and general build had also disappeared from the neighborhood, threatening to commit suicide. Was it murder or not? In the laboratory the skeleton tallied closely with a description of both men. The solution of the case depended on that missing leg! Had it been burned off, or had it been amputated years before?

The anthropologist reasoned that if the leg had been amputated, the pelvic bone on that side should be smaller and its internal texture weaker, due to years of lighter service. A short examination with calipers and microscope showed that these things were true; this was a man with an artificial leg. For a check, it was found that the bone did not show a ragged burned end, but was smooth and round just as it had healed long before. Therefore, the suicide theory was proved.

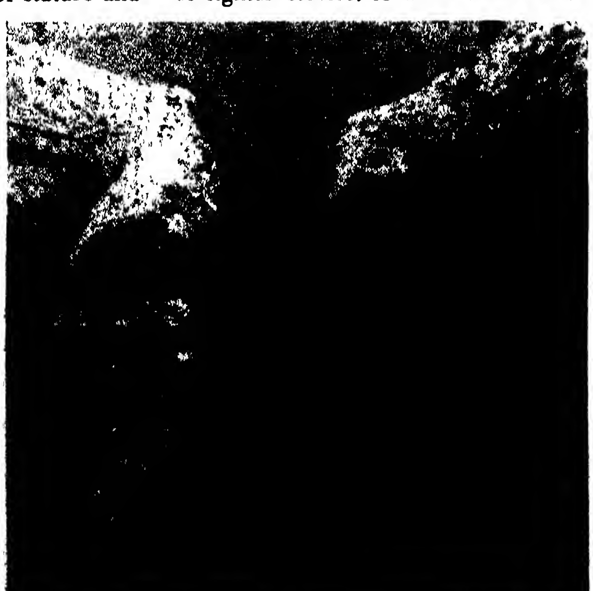
The bones may or may not register cause of death. A knife-wound in the abdomen, a slit throat, most poisons (lead is an exception), leave no trace to be discerned in the skeleton. But bullet-wounds often leave bony evidence. The ballistics expert must aid in determining caliber and other vital facts, but often only the anatomist can gage direction of fire, angle of penetration, and even—in shotgun cases—distance, based on the spread, or "pattern," of the shot. In a recent case, a study of these factors substantiated a claim of self-defense, thus changing a murder charge to one of manslaughter.



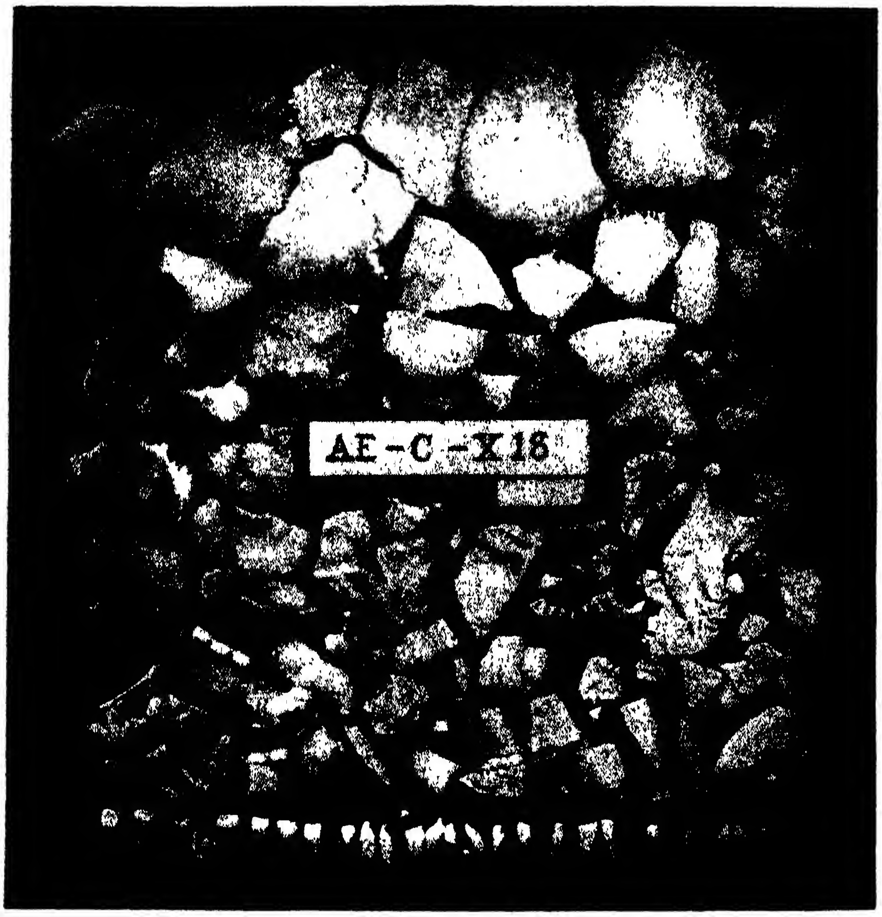
Reading from left to right, the photographs at top and the X-ray pictures at bottom are the upper arm bones of: White, female, aged 18; Negro, male, aged 19; Negro, female, aged 20; and white, male, aged 37. This series illustrates the progressive union of epiphysis (cap at end of bone) with diaphysis (shaft of the bone), according to age

The bones do not always tell of guilt; they sometimes establish innocence. In a case of suspected child-abduction, the cellar of the suspect was dug up and a number of small bones was found. Were they the bones of the child? No. They were: the bones of sheep of five different ages, the bones of a rat, the bones of a pigeon, the bones of a barnyard owl, the bones of a goose, the bones of a turkey, the bones of cows of four different ages. Where did they all come from? Man and rodent had placed them there—the former, by throwing away mealtime remains of sheep, turkey, goose, cow; the latter, by dragging in pigeon and owl, and leaving his own bones.

Can the bony remnants of the human



At the age of 38 years, the pubic symphysis shows a radical change from that of a younger age (see opposite photograph). Due to decreased blood supply, the surfaces become dry and brittle. In this one, the "billowing" has been replaced by a clearly outlined, rough granular area



Above and to the right are 104 fragments of a skull as received, and the skull as restored. It is the skull of a white female, aged about 25, and is one of the oldest historic skulls recovered to date, going back to before 3000 B.C. Recovered in Anatolia, Asia Minor, it was restored by W. H. Sassaman, Western Reserve University

All photographs are from the Laboratory of Anatomy and Physical Anthropology, Western Reserve University.

face give us any idea of how the *features* looked in life? Yes, the face can be rebuilt so accurately that it is a 90 to 10 chance that identification can be made at a glance. The medical dissection of hundreds of bodies, and the careful measurement of tissue thickness at certain points all over the jaw, face, and skull have established the difference between measurements in the living and the dead. On the skull selected, depth-points are indicated by small bits of clay modelled to the exact tissue thickness at that point. When these are all in position, the space in between is filled out to a more or less uniform thickness, depending on contoural variations. "Soft" details of lips and ears are added, the skin-color touched in, and the clay takes on the likeness of the living person. The race to which the living person belonged having been determined from his bones, the facial features are molded accordingly.

THE skeleton, especially of a child, carries with it the evidence of disease, which may appear in the texture of the bones or in their size and shape. In malnutrition, the bones will be twisted, brittle, or imperfectly formed. In such cases, the X ray reveals white lines running across the bones, representing the times when their growth was halted. Measles, scarlet fever, and many other illnesses leave these telltale scars of arrested development. Knowing the normal rate at which bones build themselves up, the scientist can easily compute the age at which such illnesses occurred.

A few years ago the skeletons of two small children were found in an Indian mound in Missouri. Examination showed them to have been white, however, aged two and five years. A few wrought-iron coffin nails around them indicated an orderly burial about 100 years before. Why had they been buried there, in what must have been hostile country? A study of the little bones gave a partial answer. Both children had been victims of long-continued malnutrition. The picture recreated by the scientists was of an emigrant family, wearily trekking westward across Indian-infested plains, their throats parched by heat and dust, their bodies emaciated by lack of fresh food and good water. The children had finally died, to be buried in haste in the one place the Indians would be least likely to find them.

Today the scientist's knowledge of bone growth is turned to answering the all-important question: What is a healthy child? He can tell, almost to the day, when this bone or that should increase in size, shape, appearance, and texture, and whether the bones are taking minerals and salts as they should. With the X ray, he is able to make his studies as accurately as though he held the bare skeleton in his hands. If all is going well with the child's development, its bony structure will be exactly on schedule in every detail. But if the X ray shows that the bones contain the telltale white lines of arrested growth, or if they have wandered from the norm in shape, size, or proportion, then the danger signal has been hoisted and something must be done. Health history is then checked minutely, the diet is remodelled and the necessary treatment is started before it is too late.

Thus the mute and nerveless skeleton, which seems to the layman the one unvarying human constant, is actually never the same in two persons, nor for that matter, does it remain unchanged for long in any given individual. It alters with our years, and is a telltale index of our health, our way of life, and frequently enough the manner of our death. The bony structure which supports our fleshy envelope is in truth science's best indicator of the history of the individual and the race, and a valuable source of data which could never be found in any other way. All of our knowledge of Man's evolution and development rests on the firm foundation of his bones.

OUR POINT OF VIEW

Monday Holidays

CALENDAR reform, discussed in past issues of this magazine, has many drawbacks, many opponents. Planned to simplify and systematize our daily social and business lives, many of the proposed reforms would require such an upheaval of existing routine as to make them economically impractical.

There is one reform, however, that does not necessitate major calendar changes, does not interfere with established programs of business and industry. This is the proposal to shift each year the dates of all national holidays so that they will fall on the nearest Monday. The sociological implications of the idea are immediately apparent. Leisure today is something that produces tangible results, is of as great benefit to those who utilize it as it is to their employers. With all holidays falling on Mondays, the resulting two, two and a half, or three day holidays would permit workers to take full advantage of available recreational facilities, to pursue to the fullest their chosen hobbies, to return to their daily labors with a new zest that could not be fully regenerated by shorter weekends and single holidays scattered by the variations of the existing calendar.

Few if any business men and industrialists will dispute the logic of Monday holidays, unless they are motivated by emotionalism. Those whose emotions rule their logic probably will make a strong fight against moving the dates of holidays that have become fixtures through long association, however erroneous in conception. For example: Astronomically a new year does not start exactly on the first second of January 1; Washington was not born on February 22; Memorial Day is an arbitrary date; The Declaration of Independence was not signed on July 4; Thanksgiving Day need not always be on Thursday; December 25 as the birth date of Christ is a moot question with many people.

Enough has been said to show that Monday holidays are desirable and do not involve sacrilege. If sentimental emotions regarding certain dates on the calendar can be suppressed long enough to legalize Monday holidays, and for people to become reconciled to the change, a worthwhile contribution will have been made to life and its enjoyment. Since holidays are desirable, are necessary to life as we live it today, why should not the opportunity be grasped to make the most of them? A start was made years ago when, in 1894, Labor Day was created as a legal Monday holiday. Why not extend the same idea to cover all holidays and thus reap greater benefits for each individual and for the economic and social structure of which he is such an important part?—*A. P. P.*

Ducks or Mosquitoes?

"WHEN it comes to a question of ducks or human lives, let us forget the ducks." Thus does our friend, the *Engineering News-Record*, hurl a challenge in an editorial decrying the efforts of game conservationists to establish marsh refuges for "ducks, birds, and marsh animals." The argument, as that journal sees it, lies between mosquito control and no mosquito control, the latter situation resulting in 10,000 deaths per year from malaria—a mosquito-borne disease—in the southern states alone.

By all means let us forget the ducks, if that is the only alternative. Fortunately it is not. Nevertheless, the quoted sentence tends to obscure many pertinent factors, for it appeals to emotions which, once called up, blanket all reason.

Having no more than a scientific interest in waterfowl, this writer feels that the *Engineering News-Record* views the subject narrowly. Some engineers, perhaps, enjoy the job of draining lands indiscriminately. On the other hand, for every such engineer in this country, there are dozens of bird lovers—men, women, and children who wish to preserve our native bird life. These are not "a privileged few" who "may slaughter at leisure." Man has already upset Nature's balance too much. It is time to begin working out certain readjustments, and these bird lovers want to see the work begun. Of course many sportsmen also are interested—and their interest has an economic value totalling hundreds of millions of dollars annually.

As to mosquito-borne malaria, let's not sugggest that the entire 10,000 annual deaths in the south are due wholly to mosquitoes from marshy areas frequented by waterfowl (mosquitoes also breed in tin cans and rain barrels), or that the marshes whence they came could ever be drained economically, or that the deaths might not be lowered greatly by proper precautions and medical attention. In other words, there are too many other relevant factors for the blame to be laid to waterfowl marshes, some of which no one would ever bother to drain anyhow.

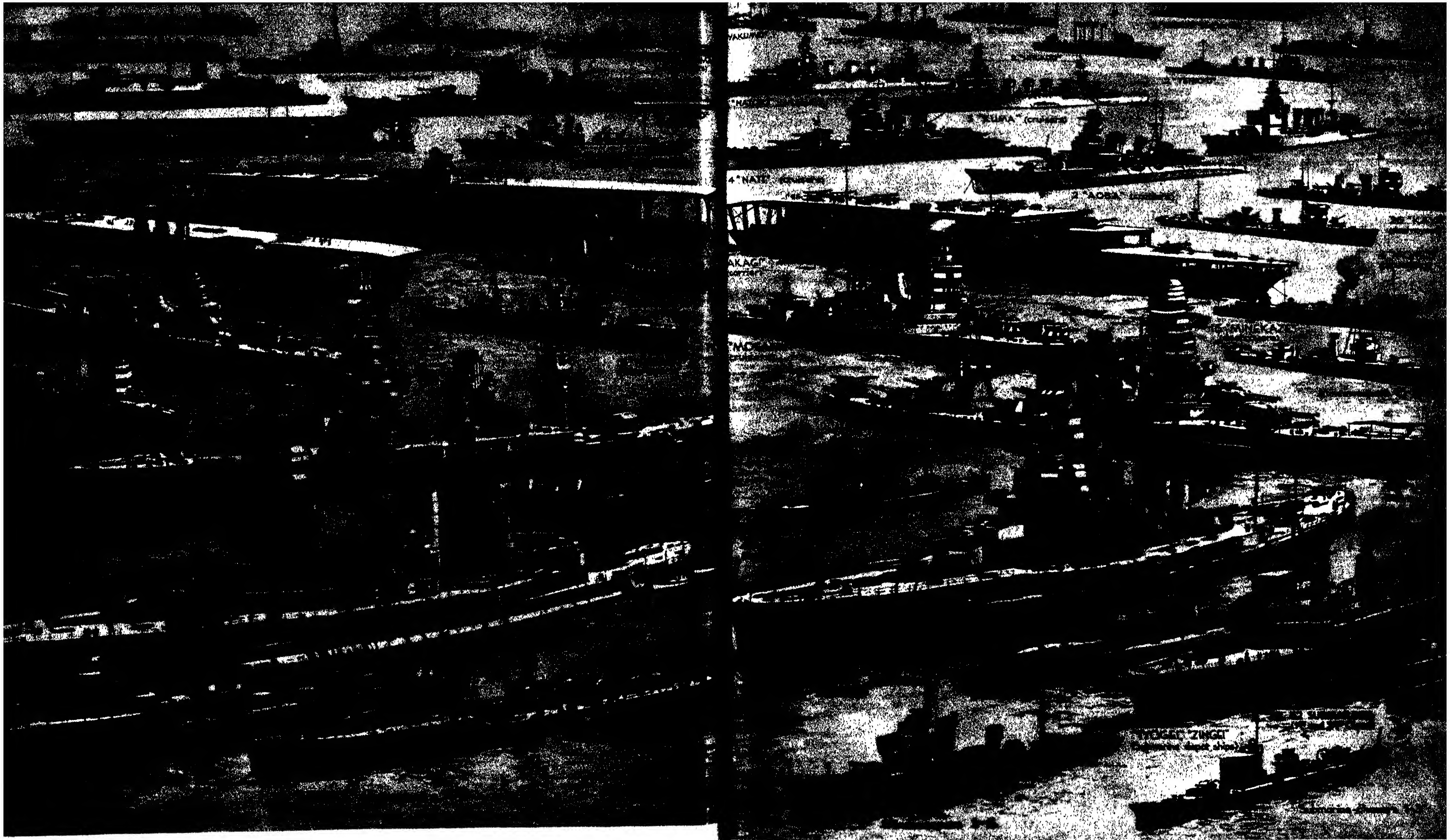
The subject is too big to cover in a few hundred editorial words which wind up with such a pessimistic alternative as that quoted. It is suggested, therefore, that all the facts be examined. There surely must be a point of compromise that can be found by those studying the facts intelligently and with open minds and humane hearts.—*F. D. M.*

Our Rebel Collection

TO those of our readers who admit an interest in the odd and unusual, as exhibited in the workings of the human mind, we have often thought of revealing one aspect of an editor's duties for which no corresponding evidence appears in the published periodical. Arriving with the manuscripts that are considered seriously for publication are usually to be found a few which, could they but be published, might provide the readers—or at least those of them having curiosity about curiosa—almost as much return in entertainment, even if not of value, as the more dependable information regularly presented. These are the scientific hypotheses of the studiously unorthodox. All men of science frequently receive such hypotheses from those who are in rebellion against what they term "orthodox science," but the editors of journals of popularized science probably receive more than any scientist—unless it be Professor Einstein, who recently told us that one of his biggest problems was to sort his worthwhile mail from this kind of communications.

It seems to be almost nothing for a man without much scientific training to sit down and solve the subtlest secrets of the universe—the nature of matter and of life, for example—in a single session. Failing to obtain publishers after trying all magazines, they do their own publishing, and thus for many years we have been receiving curiosa, both pamphlets and books: "Newton's Law Disproved." "The Riddle of the Universe Solved." "Rex Rays—the Great Discovery." "Avity, the Secret of Gravity." These are but four—we could go on naming them to a pageful. But for a sense of detachment and perhaps of humor, these offerings, usually attacking prominent scientists with venom, might jaundice an editor's life. Instead, we collect them!

Years ago, when starting this collection, we wondered whether it would not pay science to deputize a scientist to examine them all, in hope of finding occasional pay-dirt. Today we believe we were wrong. Instead, we hope to deposit them permanently in some university library of the history of science. Future historians might otherwise judge that, in our era, pseudo-science was already extinct.—*A. G. I.*



The Japanese Navy at a Glance

"PROBLEM CHILD" of world naval discussions, the Japanese Navy is also one of the least known outside of Japan. Hence this drawing by the naval authority, Dr. Oscar Parkes, is as illuminating in its completeness as it is interesting in its technique and detail. It is the first of several on navies of the world naval powers which we will publish this year through the courtesy of *The Illustrated London News.* In this drawing we note certain characteristics unique in Japanese men-of-war. The enormous pagoda-like foremasts, around which the Japanese have clustered an extreme number of navigation, fire control, and operating cabins, constitute the first. These, together with excessive top hamper elsewhere, make many Japanese ships "stiff"; they roll less and thus are steadier gun-platforms, but, on the other hand, are more likely to sink rapidly after being hit badly enough to let in a quantity of water. One new torpedo-boat, the *Tomoduru,* actually capsized during maneuvers, and there have been rumors—the Japanese jealously guard all naval data—that other new ships have performed badly on trials. Consequently, the design of the *Ariake* class of destroyers and of the *Tidori* torpedo-boats had to be changed. Another feature of Japanese warships is the abundance of curves in hull and superstructure. Many stacks also curve in awkward fashion, while many "rake" very sharply. In this drawing is shown the reconstructed aircraft carrier *Kaga,* a longer flight deck having been provided by an extension over her forecastle. Alterations have also been made on the battleships *Nagato* and *Mutu*—increased deck protection, new machinery, aircraft, and other improvements.

There can be given no details of Japan's program for future naval construction. Great Britain and the United States attempted, last February, to obtain a statement of Japanese building plans, but the request met with a sharp reply. Hence these two countries have decided, in conference, on an upper limit for battleships of 45,000 tons, with 16-inch guns.

THE 200-INCH TELESCOPE

A Progress Report . . . Two Years to Go . . . The Big Moving Mechanism Weighing a Million Pounds Has the Precision Characteristics of a Fine Watch

By CAPT. C. S. McDOWELL, U.S.N., Supervising Engineer
With Illustrations by Russell W. Porter

THE general story of the 200-inch telescope was given by Dr. George Ellery Hale in Scientific American, May, 1936. In the November number of that year some of the developments of the project also were described and illustrated in an article prepared by the author and the illustrator. At that time—two years ago—we were talking about designs which were still mostly on paper, and were describing what was going to be done, but now many of these designs have become a reality and some of the parts of the telescope have been completed. There will be probably two remaining years of work in checking, assembling, and testing the main parts of the telescope itself, and in completing the grinding, polishing, and testing of the main and auxiliary mirrors.

I have been told by the editor that there is a desire on the part of the readers of this magazine to know more of the details of the telescope tube and its mounting; also, of the dome which will house it. The five sketches which illustrate this article show the special features better than words can tell, though some explanatory notes have been added.

A concrete and steel dome, 137 feet in diameter (see the frontispiece, page 60), has now been completely erected on Palomar Mountain and is ready to receive the 200-inch telescope. The 200-inch telescope tube and its mounting are nearing completion at the South Philadelphia Works of the Westinghouse Electric and Manufacturing Company and will be shipped to Palomar Mountain for installation this summer.

The lower, or stationary part of the dome, has a steel framework to take the bearing loads and has a double outer wall of reinforced concrete, 30 feet high. Between the outer and inner walls there is a 12-inch air space which permits the escape of heated air through connections to a similar air space in the upper dome, where it is vented at the top. This space helps to eliminate heat from the lower spaces of the dome. Also, the inner wall is insulated. These two precautions, aimed at the reduction of the ill optical effects of small temperature differences on the telescope mirrors and on the path traversed by the light, will keep the space below the observing floor near the outside night air temperature. Early each night the air in the lower dome will be pumped out and this space filled with cool night air, so that there will be no gradual accumulation of heat in the lower dome.

Figure 1

On the lower floor, shown in the frontispiece, there is the astronomers' workshop—where they will develop plates, carry on their studies and "loaf," —consisting of dark rooms, physical and chemical laboratories, a library and lounge, lunch room, astronomers' offices, air-conditioning machinery, and a storage space for material and equipment. A passenger elevator is provided between the ground floor and mezzanine and operating floors and the balcony just above the operating floor. From the balcony landing a short stair leads to the prime focus platform extending toward the prime focus observing station at the top of the telescope tube, which is accessible by a method to be explained later. Thus the facilities on this lower floor are easily and readily accessible to the astronomers from all observing stations.

THERE is a structural steel base-frame which supports the telescope mounting. This base-frame has its own foundations separate from those of the dome. Tests have shown that there is a very low "coefficient of coupling" between this base-frame and the dome, practically preventing any vibrations, which may be set up in the dome, from reaching the telescope. The base-frame supports, on its upper part, four pedestals which project through the upper floor and carry the cross girders, which in turn provide supports for the north and south—or polar axis—bearings. Midway between the lower and observing floors is a mezzanine floor extending over half the dome. This provides space for the main electrical distribution and control panels, motor-generator sets, time standards, storage batteries, and so on. It will also provide storage space for spectrographs and other equipment.

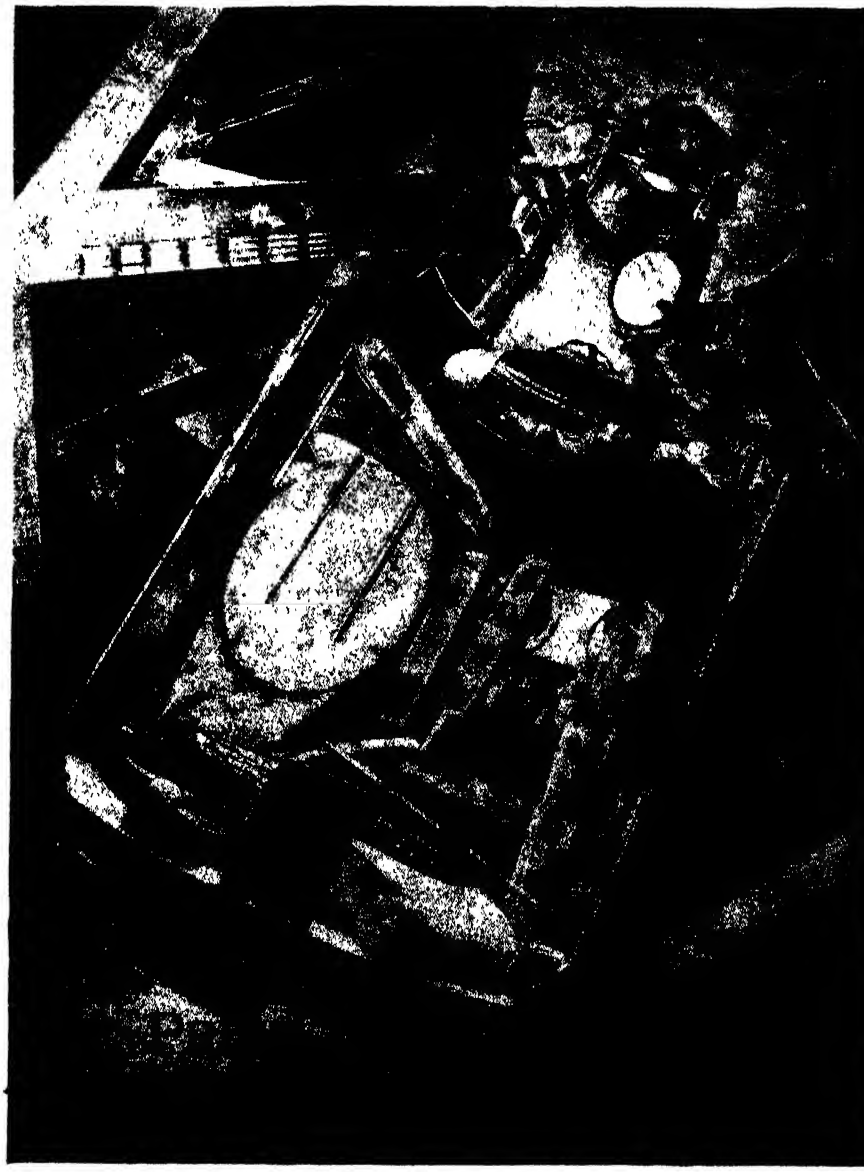


Figure 2

The upper or rotating part of the dome is a completely welded steel structure covered with ⅜-inch butt-welded steel plates. These plates form the outer shell of the dome. This dome is supported through springs on 32 four-wheel trucks which roll on an accurately ground circular track. The meridian section shown in the frontispiece is taken along one of the main arches with the shutter open. One of these shutters is seen over the main arch. Directly under the arch is the 60-ton crane, installed to facilitate the assembly of the telescope. An adjustable wind screen is arranged in the 30-foot-wide shutter opening to avoid any undesirable air currents when the telescope is pointing to the region of the skies near the zenith.

In order to keep the day temperature inside the dome close to the prevailing night temperature, the rotating dome is lined on the inner surface with panels of aluminum foil insulation. These panels are inside the ribs of the dome and provide a four-foot air space, with vents at the top of the dome. The panels are faced with aluminum on their inner side, thus providing a smooth interior surface of aluminum for the dome.

The 200-inch telescope has an equatorial type of mounting. The complete optical system comprises eight mirrors which are carried entirely on the telescope tube and mounting. The 200-inch mirror, supported on 36 compensating mechanisms, is located within the bottom ring of the tube (Figure 1). The reflected image is formed at the prime focus ($f/3.3$) in the observer's house, which house is supported on knife-edges —thin edgewise strips of steel best shown in Figure 3—from the cage at the upper end of the tube. Underneath the observer's house and only narrowly separated from it is another chamber mounted on the cage or upper, circular part of the square tube, and containing three auxiliary mirrors with their moving mechanisms. These mirrors, shown in Figure 2, are used, one at a time, for forming images at (1) the Cassegrain focus, $f/16$, located beneath the lower end of the tube, as shown in the frontispiece and in Figure 1, and (2) at the coudé focus, $f/30$, located in a constant temperature room at the south end of the dome (frontispiece, at left side); either two or four auxiliary mirrors are used for the work at the coudé focus. (3) Another three-mirror combination forms an image inside the tubular girders of the mounting at the coudé-Cassegrain focus ($f/16$). The light path for various mirror combinations used is indicated on the sketches. The prime focus is intended to be used generally for direct photography, while the work at the coudé and the Cassegrain foci will be mainly with spectrographs.

The entire tube, over 55 feet long and 22 feet wide, weighing approximately 250,000 pounds, is suspended on the declination axis trunnions from the mounting which forms the polar axis of the telescope. The mounting or yoke (frontispiece) consists of two 10½-foot diameter welded steel tubular girders

joined at the south (lower) end by a cross-member (Figure 4) containing the south bearing and at the north end by a horseshoe-shaped, 46-foot diameter box girder forming the journal of the north bearing. The bearings of the telescope are of the forced-feed oil-pad type. At the north end, the horseshoe is supported on two equalized pairs of oil pads spaced at an angle of 60°. The south bearing is formed by an 84-inch diameter spherical cup resting on three self-aligning pads (Figure 4). When a continuous flow of oil, under high pressure, is delivered through orifices to the surface of the pads, an oil film is formed between the pads and the horseshoe or the spherical cup at the north and south ends, respectively, thus floating the 1,000,000 pound weight of the 200-inch telescope.

The tube is turned north and south in declination by an accurate 14-foot 3-inch diameter worm gear, shown in the frontispiece at the lower end of the polar axis, also in Figure 4. Two worm gears of the same size are carried on bearings at the south pedestal and drive the entire telescope east or west in right ascension through a torque tube. One of these gears is used for setting the telescope on the star at a relatively high speed of 1/8 of a revolution per minute, while the other gear is driven by a synchronous motor through a suitable worm reduction at a corrected sidereal rate of one revolution per day. By using a separate gear for driving the telescope at the higher setting speed, which imposes heavier loads and strain on the gear, excessive wear of the accurate right ascension gear is obviated.

There is a main control desk, located on the operating floor within the north pedestal (frontispiece, at right edge), from which the setting of the telescope in position and actuating the mechanisms of the shutter, dome, and of the wind screen are performed.

The 200-inch mirror (Figure 1), ground and now being polished to a concave spherical surface, later to be completed as a paraboloid, is made of boro-silicate glass having a low coefficient of thermal expansion. In order to obtain high reflectivity of light, the surface of the mirror will be aluminized.

THE total thickness of the mirror is about 25 inches and, in order to reduce its total weight, the back of the mirror is of ribbed construction. It provides a rigid structure which is relatively light and permits rapid equalization of temperature in the entire body of the glass.

The mirror is attached to the welded steel cell by means of 36 balancing mechanisms placed in ground pockets within the ribbed structure. In its turn, the cell is bolted to the bottom ring of the telescope tube.

Essential parts of the balancing mechanisms coming in contact with the glass are made of 38 percent nickel steel alloy which has a coefficient of thermal expansion identical with that of the glass. The function of these mechanisms is to distribute the mirror load evenly among them and prevent re-distribution of the individual loads on the supports at any position of the tube. The tendency of the mirror to distort, when rotated from one position to another, is thus eliminated.

In the center of the mirror is a 40½-inch diameter hole which permits the light, reflected from an auxiliary convex mirror at the top of the tube, to pass through the 200-inch disk and form an image at the Cassegrain focus ($f/16$).

When not in use, the 200-inch mirror is protected by a strong, mechanically operated cover. This cover is thermally insulated and, by means of overlapping auxiliary leaves on the under side of the main leaves, a modified iris diaphragm (Figure 1) is formed. This permits "stopping down" the aperture of the 200-inch mirror, when desired, during some astronomical observations.

Directly underneath the observer's house is another six-foot diameter chamber containing the auxiliary Cassegrain and two coudé mirrors. All these mirrors have to be out of the way of the light beam when work is carried on at the prime focus, and only one of them is used at a time for work at the Cassegrain or coudé foci. Accurate positioning and locking mechanisms are therefore provided in the chamber, in order automatically to operate the mirrors with their counterbalances. A quick change-over for work at different focal points will thus be obtained on the 200-inch telescope. On smaller telescopes built previously, single mirrors are permanently attached to several cages; changing of the cages on the telescope tube

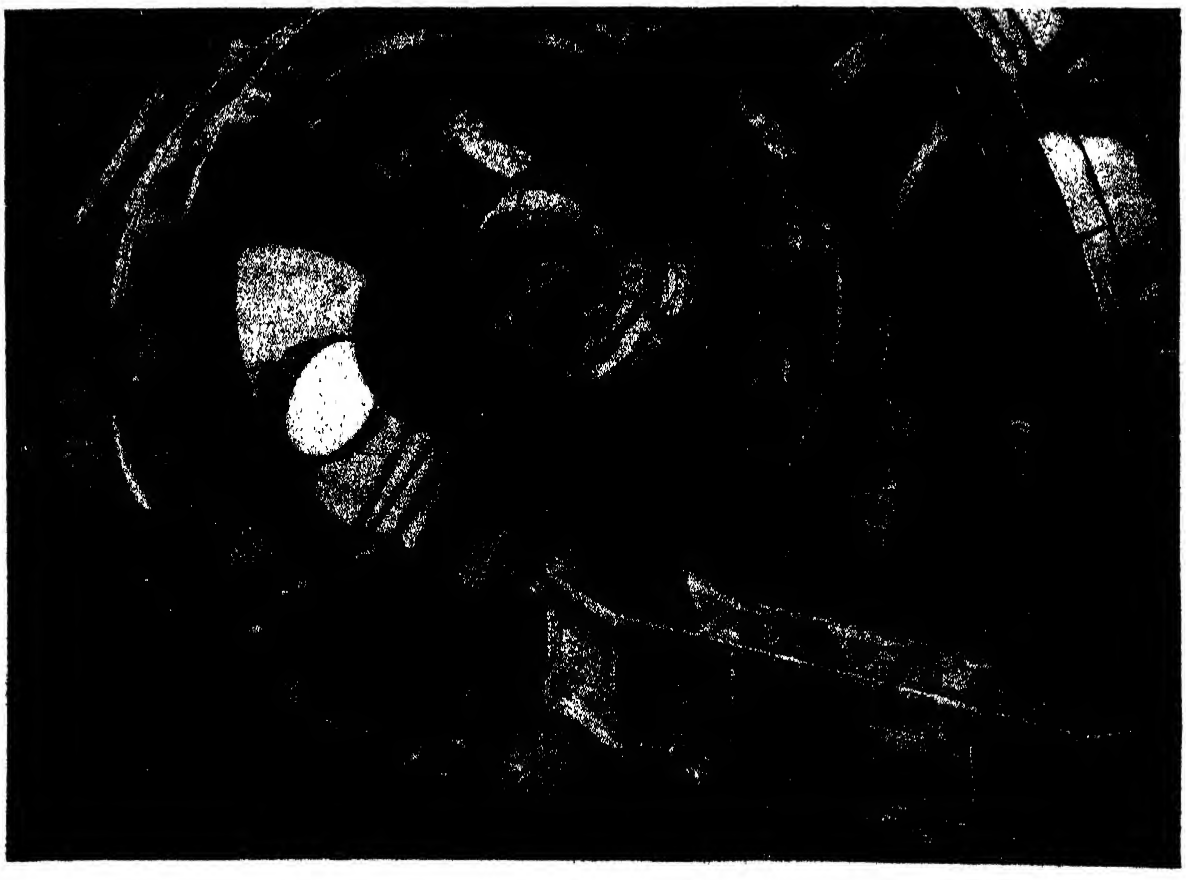


Figure 3

Figure 4

naturally consumes considerable time.

The six-foot diameter observer's house (Figure 3) at the prime focus contains the plate holder with its guiding eyepieces and Ross correcting lenses which permit sharp definition of the image over a field larger than ordinarily obtained. A special chair with a leveling device permits the observer to remain in a comfortable upright position independently of the position of the tube. The chamber will be fitted with telescope position indicators, and a telephone to permit the observer to communicate with his assistant at the main control desk 65 feet below him.

The access to the prime focus is obtained from a special platform running on an arc along the main arch of the dome. It maintains a constant clearance with the observer's house so that the observer may get in and out at any position of the tube.

Other interesting features seen in Figure 3 are, just above the end of the platform, one of the flexible spoke gimbals at the declination axis on the east panel of the tube[1]; and, in the center of the tube, in line with the declination axis, the first coudé flat mirror. This mirror is not used when observations are carried on at the prime and Cassegrain foci.

In Figure 4, the 84-inch diameter spherical cup and the three oil pads forming the south polar bearings previously mentioned, are shown in greater detail. The south bearing carries part of the radial and the entire thrust load of the telescope. A heavy flange is welded to the upper end of the spherical bearing cup. This flange is bolted to the cross-member of the telescope yoke and is connected by means of a flexible diaphragm to the torque tube protruding through the bearing and yoke. The south end of the torque tube is connected through a similar diaphragm to the "fast" setting right ascension worm gear. While the instrument is being set in position, the accurate driving worm gear arranged directly above the setting gear is floating on its bearings. When the telescope is pointing to the desired object in the heavens and is ready for observation, the worms driving the two gears are synchronized and both run at the clock speed. The accurate gear driven by the clock worm is then clutched to the lower gear connected to the torque tube, the thrust of the "fast" worm being simultaneously released. The two worm gears are of split wheel construction, permitting correction of the initial tooth spacing errors by means of lapping during their manufacture.

On the under side of the yoke cross-member is seen, just at left of center in Figure 4, a sheave carrying two four-inch diameter electrical wire cables which distribute current to the declination drive and other motors on the yoke and tube.

A spectrograph will be installed in the east 10½-foot diameter tubular girder of the yoke with its slit at the Cassegrain-coudé focus. A circular stairway and rotating platform inside this tubular girder permit free access and work at the spectrograph.

The tilting arch-shaped gantry crane mounted on the yoke (shown also in the frontispiece as an upward-projecting arm) carries the second flat of the 5-mirror coudé combination. This gantry is mounted on its bearings on the 24-inch diameter diagonal stiffening members of the yoke and when not in use is swung back toward the south cross-member of the yoke.

The third coudé flat for the same mirror arrangement is seen in position inside the torque tube of the telescope.

To realize the magnitude of this undertaking, the layman must note the law confronting the engineer: line dimensions increase in volume as their cube. So, by jumping from the largest existing telescope, 100 inches, to double that aperture, mechanical conditions have arisen which explain in part the complex problems described.

The design of the various parts of the project has been the result of intensive study by many people throughout the country, to whom it is impossible to give proper credit, but all their combined efforts are gratefully acknowledged.

[1]The declination trunnion, of which these gimbals are a part, was described and illustrated in Scientific American, February, 1937, page 116.

HELIUM—HOPE OF THE AIRSHIP

Commercial Quantities Produced Only in United States . . . Safer, More Economical Lifting Gas than Hydrogen . . . Stringent Sales Regulations

By PAUL H. WILKINSON
Author of "Diesel Aircraft Engines"

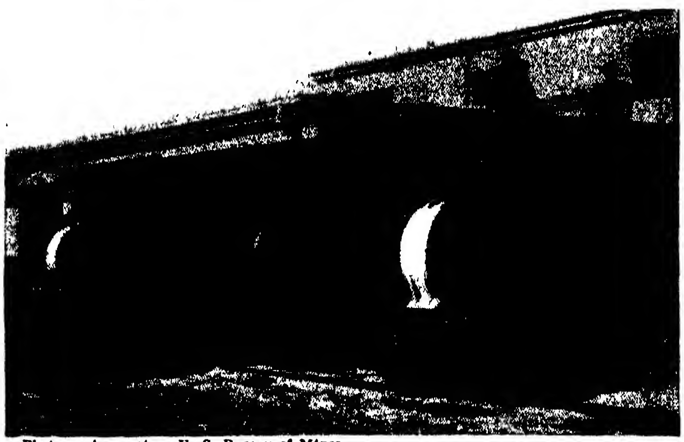
WHEN Congress approved the Helium Act on September 1, 1937, it appeared that a new era was being inaugurated for lighter-than-air transportation. Previously the Zeppelin, dependent upon inflammable hydrogen for its lifting gas, had proved far too dangerous; now, with fireproof helium, it could again assume its place in aviation.

The story of helium is one of the romances of science. It was in 1868, when the French astronomer Janssen and a group of fellow scientists were in India to view a total eclipse of the sun, that they first found the bright yellow spectrum line of the element in the chromosphere surrounding the sun. Simultaneously with its discovery in the Far East, Sir J. Norman Lockyer, the brilliant astrophysicist, announced the finding of the spectrum line of the new element while making observations of the sun in England. So convinced was the Englishman that the gas was not any substance known on earth, that he coined the name "helium" for it, from the Greek word "helios," sun.

The presence of helium on the earth was not detected until 1895, when Sir William Ramsey, the eminent English scientist, identified it as an inert, colorless and odorless gas which he obtained from radio-active ore. Later, it was found to exist in the atmosphere in the proportion of 1 part of helium to 185,000 parts of air, and in minute quantities in sea and river water and in gases emitted from mineral springs and volcanoes. As the quantities obtainable from these sources are far too small for commercial purposes, it is indeed fortunate that an adequate supply has been found in natural gas in certain parts of the United States.

Helium belongs to the family of rare, inert gases, so-called because of their comparative scarcity and extreme chemical inactivity. It will not support combustion, nor will it explode when mixed with air. Prior to 1917, it was obtained in very small quantities in scientific laboratories from radio-active minerals such as cleveite, pitchblende, and monazite. Costing $2500 a cubic foot, its production in this manner was commercially impractical. When the United States entered the World War, the urgent need for non-inflammable gas to replace hydrogen in observation balloons and airships led to intensive search for an adequate source of supply. Helium had been found in natural gas in various parts of the country; the Bureau of Mines, together with the Army, the Navy, and the Linde Air Products Company, worked on the problem until commercial production of helium was assured. That they were highly successful is evinced by the fact that many millions of cubic feet of helium have since been produced at a cost of less than one cent a cubic foot.

AT press time, it appears that the National Munitions Control Board will not permit the sale of helium to Germany. Five members of that board, fully aware of the desirability of that sale and of the salutary effect that it would have on lighter-than-air craft progress, were over-ruled by the sixth member. It is a crime against science, a shameful commentary on human nature, that obvious personal prejudices should be permitted to shut the door against development of a useful science.—*The Editor.*



Photographs courtesy U. S. Bureau of Mines

Special Army Air Corps steel tank car for transportation of helium, under a pressure of 2000 pounds per square inch

Most of the helium used today comes from the vast natural gas resources in North America. It is found on other continents, too, but not in sufficient quantities to warrant production. Canada has two helium-bearing gas-sand areas in Alberta and Ontario, where the precious gas has been found in content up to 0.82 percent. An experimental plant set up at Calgary produced some 60,000 cubic feet of it before it was closed down. In much smaller quantities, it has been found in natural gas in Germany, Rumania, Australia, New Zealand, and Japan. In Germany, where it is needed so badly, the content is said not to exceed 0.2 percent. Ample supplies appear to exist in the U.S.S.R., inasmuch as helium-filled dirigibles are reported to be in operation there.

The United States has a virtual world monopoly on helium, as it is the only country where it is now produced in commercial quantities. Most of it comes from natural gas wells on the government-owned Cliffside structure near Amarillo, Texas, where 50,000 acres have been reserved for its production. There the helium-bearing gas-sands, lying at a depth of 3600 feet, are conservatively estimated to contain 1,800,000,000 cubic feet of the precious element. Other government reserves are located at Woodside and Harley Dome in Utah, where 600,000,000 and 100,000,000 cubic feet of helium respectively lie undeveloped as a safeguard for our national defence. In accordance with the powers granted to it by the Helium Act, the government recently completed its helium control in this country by purchasing from the Girdler Corporation its properties and extraction plants at Dexter, Kansas, and Thatcher, Colorado, from which 10,000,000 cubic feet of the gas have been obtained during the past ten years.

Separation of the helium from the other constituents of natural gas is comparatively simple and makes use of the fact that helium is more difficult to liquefy than the other constituents with which it is mixed. At the temperature of 300 degrees below zero, Fahrenheit, to which the natural gas is subjected, air is a liquid and carbon dioxide is a solid. Produced by this method, helium has a purity of about 98.3 percent.

Storage facilities are provided at the Bureau of Mines extraction plant near Amarillo for 3,500,000 cubic feet of helium, which is compressed in steel cylinders at a pressure of 1500 pounds per square inch. For shipment, it is compressed into small steel cylinders of the oxygen type, or into larger containers mounted on flat cars. The small cylinders hold 180 cubic feet of helium compressed into 2½ cubic feet of space, while the three containers comprising a tank-car lot have a capacity of 1500 cubic feet and hold 210,000 cubic feet of the gas. The maximum pressure allowed for shipment is 2500 pounds per square inch.

THE chief use for helium, of course, is as a lifting gas for airships and balloons. Although it weighs nearly twice as much as hydrogen, nevertheless it has 92.6 percent of the lifting power. By way of comparison, 1000 cubic feet of helium weigh 11.11 pounds and exert a lift of 65.82 pounds, while the same amount of hydrogen weighs 5.60 pounds and exerts a lifting force of 71.04 pounds. This difference in weight and lifting power is quite important when large airships the size of the *LZ-130* are concerned. The *LZ-130* originally was designed for approximately 7,000,000 cubic feet of hydrogen; when it was decided to use helium instead, this resulted in an increase in weight of 38,570 pounds and a loss in lift of 36,540 pounds. This could only be compensated for by increasing the size of the airship or by reducing its payload. Structurally, the ship was too far advanced to make any changes and so its passenger accommodations have been reduced from 70 to 40 persons. The *LZ-131*, on which construction has just commenced, will be 12½ percent larger in volumetric capacity and thus will have sufficient lift for 80 passengers.

Gas diffusion and contamination is one of the major problems of the airship. The slow but constant diffusion of air into the gas cells, and of the lifting gas out into the atmosphere, gradually contaminates the gas and reduces its lifting power, making it necessary to empty the cells and replenish them at frequent intervals. If the airship is filled with hydrogen, this may have to be done several times a year and the contaminated gas discarded, as it is much too dangerous to try to purify such an explosive mixture. When helium is used, however, the rate of diffusion and contamination is much slower, and the gas can be drawn off safely, purified at low temperature, and pumped back into the airship for further use.

Equipment for isolating helium from natural gas at temperatures ranging lower than 300 degrees below zero, Fahrenheit

Three helium purification plants have been designed by the Bureau of Mines and constructed under its supervision. That at Lakehurst, New Jersey, which is used for servicing the Navy lighter-than-air craft stationed there, has a capacity of 20,000 cubic feet an hour and can turn out helium of 98 percent purity. Another permanent plant, at Scott Field, Illinois, has a capacity of 10,000 cubic feet an hour. This plant, and a mobile installation mounted on a flat car, belong to the Army. The cost of purifying helium varies according to the amount processed and ranges from $0.50 to $1.00 per 1000 cubic feet. This constitutes a considerable saving over hydrogen which would have to be replaced at $2.00 per 1000 cubic feet.

Cost of helium is governed to a great extent by the yearly production of the extraction plant. During the eight years that it has been in operation, the Amarillo plant has produced approximately 77,000,000 cubic feet of helium at an average cost of about $11.50 per 1000 cubic feet. At no time has the plant been operated at capacity, the largest output being 15,000,000 cubic feet during 1932. Last year, the production for the small non-rigid airships of the Army and the Navy did not exceed 4,000,000 cubic feet. During this time, the sale of the residue gas to the city of Amarillo brought in over $200,000 to the government, so that the average net cost of the helium produced to date is $8.80 per 1000 cubic feet. If the Amarillo plant should be operated at its full rated capacity of 24,000,000 cubic feet a year, it is estimated that the net cost of helium to the government could be reduced to about $4.00 per 1000 cubic feet.

Recently, the American Zeppelin Corporation, representative of Deutsche Zeppelin Reederei (the operating company), made application for 17,900,000 cubic feet of helium for the airship *LZ-130* now completed in Germany. [See accompanying Editorial Note.] This should be sufficient for a year's supply — to fill the 7,000,000 cubic-foot dirigible and replace its diffusion and valving losses.

So jealously guarded is our helium supply, that most stringent regulations have been enacted for its sale and export. Before it can be purchased at all, the approval of the Bureau of Mines and the permission of the Secretary of the Interior must first be obtained. Then, if it is desired to export the gas, a license must be obtained from the Secretary of State who issues it with the unanimous approval of the National Munitions Control Board and the Secretary of the Interior. These restrictions have been imposed to prevent its purchase by other countries for military purposes, and to conserve our national resources. In addition, there is another restriction which governs its use in the airships of other countries. This is to the effect that an airship filled with American-produced helium must always use the United States as one of the terminals of its route. In other words, an airship so filled can operate between Germany and the United States, but not between Germany and South America even though it makes this country a port of call en route.

HOW this will all work out remains to be seen. As things now stand, Germany can build the airships but has no helium, while we can produce the helium but have no large airships in which it can be used. In view of the obvious need for airship service across the ocean between North America, Europe, and South America, perhaps a compromise will be reached that will further the cause of lighter-than-air craft and will not create military complications. Whatever the arrangements may be, however, it is a foregone conclusion that the only lifting gas which will be used in these airships will be the safety gas—non-inflammable helium.

DIFFUSE NEBULAE

The New Struve Wide-Slit Spectrograph Permits the Observation of the Faint Galactic Nebulae

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory of Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ASTRONOMERS are always eager to extend their powers of observation. The most obvious way of doing this is to build bigger telescopes. This affords the only known way of advance along many important lines, and thus fully justifies its great cost. But there are other fields in which success depends upon ingenuity in design—adapting the whole instrument to the particular problem to be solved.

This is notably the case in the study of faint nebulae, and, above all, of their spectra. At first, the power of photography seemed here to be limitless, for the capacity of the plate to add up the impression made through long hours of exposure revealed details which eyes like ours can never hope to see with any telescope. Powerful cameras, with objectives of large diameter and short focus, and more sensitive plates, added their contributions; but in time a limit appeared. This comes, not from any lack of instrumental excellence or power, but from the general light of the sky. The direct light of individual stars is not seriously disturbing, for, with a suitable instrument, these show as sharp bright points on the plate (or, rather, on a positive made from it), and, were they alone present, there would be a clear dark background between them, on which nebulosity would be clearly visible. But it has been known for many years that the greater part of the light of the clear, cloudless, moonless sky is continuously distributed and forms a faint luminous veil through which the heavens are seen. Part of this comes from starlight scattered by the Earth's atmosphere—just as sunlight is scattered to form the blue daylight skies; but this is relatively small. Most of the illumination comes from two other sources—one in the atmosphere, the other far outside.

The former is of the nature of a permanent aurora. Its spectrum shows bright lines arising from oxygen atoms, and bright bands coming from nitrogen molecules, and its intensity varies considerably from night to night—rising enormously, of course, when visible auroral arches or streamers appear. The latter is caused by sunlight reflected by particles distributed in interplanetary space. These are relatively numerous near the Sun, and in the plane of the ecliptic. In this part of the skies they produce an illumination fully as bright as the Milky Way—the familiar zodiacal light—but this fades out gradually and extends, more feebly, all over the visible heavens. Could we escape from the Earth, and set up an observatory on the Moon, we would be rid of the aurora and of scattered starlight; but the zodiacal light would remain and the darkest parts of the sky would be more than one third as bright as we find it from good terrestrial stations. To get a really clear sky for observing nebulae, a space-voyager would probably have to go to the outer asteroids, or the satellites of Jupiter, if not farther.

IF we make our exposures too long, this featureless light fogs our plates, so that we gain nothing. The sky brightness may be ten times as great as that of the nebula without drowning it out entirely, if a well-timed exposure is made on a contrasting plate; but nebulae less than 5 percent as bright as the luminous foreground would probably be lost. Elvey and Rudnick, who have recently made a long series of measures of sky-brightness, conclude that the limiting brightness which could be photographed under favorable conditions corresponds to the light of a seventh magnitude star spread over a square degree.

To photograph the spectrum of a gaseous nebula is not much more difficult than to obtain a direct image, for the light is concentrated into a few bright lines. With a wide slit, or with no slit at all, each of these is replaced by an image of the nebula, and a moderate increase in the exposure time should record the strongest, at least. But if the spectrum is continuous, observation is much more difficult. The light of the nebula, already very faint, is spread out into a long band, and thus weakened, so much that, with an ordinary spectrograph designed for stars, the exposure becomes prohibitively long.

The problem was solved more than 20 years ago by Slipher, with a specially designed spectrograph, with a camera lens of large diameter and very short focus. This concentrated the light which got through the slit into a short and narrow image, and thus greatly shortened the exposures, while retaining enough detail upon the resulting plates to permit a satisfactory interpretation. It is with spectrographs of this type, fed by great telescopes, that it has been shown that the spectra of the great extra-galactic nebulae are such as would be given by clouds of stars, and that the enormous shifts of the spectral lines have been detected and measured. Of the diffuse nebulae, which lie within our Galaxy, some show gaseous spectra, and other continuous. These last are opaque or partially opaque clouds, shining by light reflected from near-by stars. In the others, most of the light comes from gas, set shining by the action of ultra-violet light. There is usually a faint continuous spectrum also, showing that some cloud-forming dust is present.

Hubble found, some years ago, that the gaseous spectrum appeared only when the star which illuminated the nebula was very hot (of spectral class B1 or earlier). This was easily explicable, for the energy necessary to get the atoms of the nebular gases into the states which emit the nebular lines is large, and to get so much into single atoms demands light of very short wave-length. Bodies approximating the properties of a standard radiator would give off such light in appreciable amounts only at temperatures of 20,000° or more.

There was however one noteworthy exception—the North America Nebula. This is named from a marked resemblance to the outline of the continent—detailed enough to enable Max Wolf, when he observed it spectroscopically, to say that the region he had photographed was "in Guatemala". Wolf found a bright-line spectrum; but there is no bright star of high temperature near-by in the sky, and the only plausible source of excitation is the great star Alpha Cygni. This is one of the most luminous stars of which we know—so bright, indeed, and so far off that its parallax is almost beyond the limit of direct measurement—but its spectrum is of Class A2, indicating a temperature less than 10,000°. If this star really excites the nebula, it must give off very much more ultra-violet light than corresponds to the surface temperature indicated both by its color and by the lines of its spectrum.

Further study of this problem was much to be desired, but, unfortunately, the nebula is so faint that only its

brightest portion was observable with the spectroscopic means which were available.

A notable advance in the spectroscopy of such faint objects has recently been announced by Dr. Otto Struve of the Yerkes Observatory. Once more the method has been the construction of a spectrograph designed especially for the purpose.

As for all faint objects, the camera, which forms the image of the spectrum, had to be of short focus and very high relative aperture. In this instrument it is a Schmidt camera, of 3¾ inches clear aperture, and the same focal length. There are two prisms—of quartz, which transmits ultra-violet light freely, 3¼ inches along the refracting edge and with faces 5½ inches long (to allow for the oblique incidence of the rays upon them).

ALL this, while obviously constituting a powerful instrument, has nothing very novel about it. But the other half of the spectrograph, which feeds light into the prisms, is quite unusual.

Ordinarily there would be a slit—worked with the utmost precision of the machinist, perhaps a quarter of an inch long, and with width adjustable, but at most a few hundredths of an inch—and a collimating lens to render the light diverged from the slit parallel before it passed through the prisms. This is necessary, because a divergent beam of light, after passing through a prism, becomes astigmatic, and can no longer be brought to a sharp focus. To feed the light into the slit a large telescope is required (or, not to put the cart before the horse, such a spectrograph is designed to be used with some large existing telescope).

This rather complicated optical system involves a considerable loss of light, partly by reflection from the surfaces of the lenses, partly by absorption of light by the glass. Struve calculates that, with the Yerkes 40-inch refractor, 70 percent of violet light (λ4000) would get through, 50 percent of the ultra-violet at λ3750, and none at all at λ3500 (for which flint glass is practically opaque).

Struve has escaped these difficulties by substituting a very wide slit—two feet long and an inch across!—for the narrow slit of the ordinary instrument, and placing it 55 feet from the prisms. With this device, the rays of light diverging from the slit are so nearly parallel that the distortion produced by passing through the prisms is too small to make any trouble, and there is no need of a collimator lens in front of the prism, or of a telescope objective in front of the slit. The slit is used only to cut out from the sky a small portion, including the nebula to be observed. Being photographed with such a short-focus camera, its image on the plate is less than 1/150 of an inch wide and abundantly sharp for practical purposes.

The whole affair is mounted on one side of the tube of the great 40-inch refractor—because this happened to be there as a convenient carrying mechanism fully equipped for pointing at any given spot in the sky and following it for hours. A very much less costly mounting, fed by a mirror turned by a driving-clock, would have served every purpose if the great telescope had not been available; and an instrument of this sort, with an effective length of 150 feet, is under construction for the McDonald Observatory in Texas.

Courtesy *Astrophysical Journal* (v. 85, No. 5)

The spectrograph, showing slit at top, diaphragm to block out sky, prism box, and the Schmidt camera. As is pointed out in the article, these elements are merely mounted *on* the great 40-inch telescope at Yerkes, because this most easily provides a suitable mounting, and they are not in any other manner related to the big telescope itself

The light-gathering power of the new spectrograph is very great. The green auroral line in the spectrum of the night sky comes up with ten minutes' exposure, and one of three or four hours brings out 20 bright lines or bands. The bright lines emitted by gaseous nebulae are different in position from these bands, and may be clearly distinguished from them, even if they are very faint. This provides a far more powerful method for detecting gaseous nebulae than a direct photograph—on which the whole light of the sky is superposed on that of the nebulae. Struve calculates that, under good conditions, a nebula may be detected which is only one sixtieth as bright as could be observed directly.

The first results obtained with this instrument are of great interest. Greenstein and Henyey have investigated a number of diffuse nebulae, most of them too faint to be studied previously. For the nebulosity near the Pleiades they confirm Slipher's results, finding that it resembles those of the brighter stars of the cluster, and shows that the nebula shines by reflected light. Almost all the other nebulae show bright lines, often accompanied by continuous spectrum. The faint nebulosity which covers a great part of the constellation of Orion shows bright lines of hydrogen, and the ultra-violet line λ3727 a forbidden line of singly ionized oxygen. In the Great Nebula of Orion, the strongest lines come from doubly ionized oxygen—showing that the atoms are much more strongly excited. As the outer nebulosities are probably at least 50 light-years distant from the stars whose light sets them shining, this is not hard to understand. Other nebulosities in Orion, nearer the very hot stars in the middle of the group, show bright lines, but a higher degree of excitation.

In the North America Nebula, Wolf's observations are confirmed. Bright lines are found and the excitation is almost as great as for the Orion nebula.

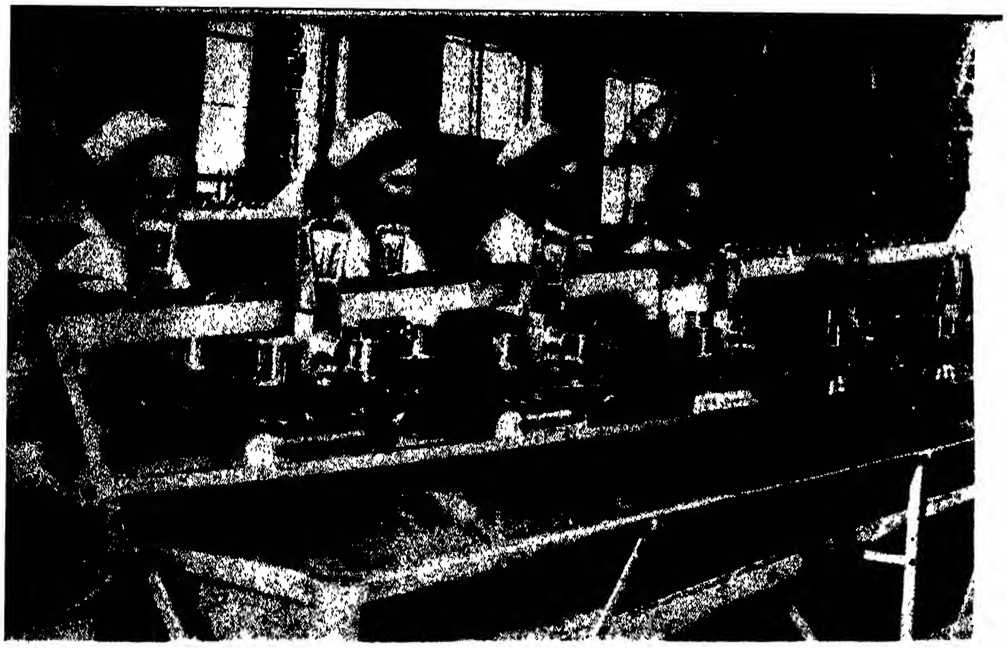
MOST interesting of all is a faint nebula near the star Gamma Cygni. This shows bright hydrogen lines, and λ3727, superposed as a fairly strong continuous spectrum. The exciting star in this case, though a super-giant of very high real brightness, has a spectrum about like that of the Sun, and both the color of its light and the relative strength of the spectral lines, throughout the visible region, indicate that the temperature of its atmosphere is very nearly the same as for the Sun.

The evidence of these two nebulae indicates very strongly that some relatively cool stars emit ultra-violet light, of very short wave-length (less than 1000 Angstroms) of very much greater intensity than hot solid bodies could do if they gave off the same sort of visible radiation.

This is by no means inexplicable. The light we get from the Sun, or from any star, is a mixture of radiation from different depths in the hazy outer layers. For visible light, the opacity is considerable, and the depth from which the light succeeds in escaping is not great. If the gases are much more transparent for ultra-violet light, this will be able to escape from deeper and hotter layers, and will be much stronger than it otherwise would.

It is noteworthy that both Alpha and Gamma Cygni are stars of very high luminosity. Some recent theoretical work by Kosirev and Chandrasekhar predicts that such an effect should occur in stars surrounded by extensive atmospheres of low density—that is, in just such cases as the present.

Further observations with this powerful instrument will be awaited with great interest.—*American Farm School, Saloniki, Greece, April 28, 1938.*



A battery of scales at this filling table in a mushroom packing plant makes it possible for the operators rapidly to fill each of the cans with exactly the same quantity of the delicacies

SCALES OF INDUSTRY

By ROGER WILLIAM RIIS

ONE of the marked trends in present-day industry is toward the use of weight as a means not only of checking quantity and quality, but of actually controlling processes of manufacture. Like many trends, this one has advanced so steadily that the full scope of it is not generally realized. A critical view of some of the principles involved and of some of the actual applications of those principles is likely to be strongly suggestive to any manufacturer.

There is an excellent mechanical reason for using weight as a means of control whenever possible. Weight is gravity in action; gravity is the one unchanging force known in the world. Every other force, every other source of power, changes and shifts. The heat received from the sun fluctuates from day to day, even from minute to minute; tides vary; different kinds of fuels give different values in heat units; electric voltages rise and fall and at times are accidentally stopped. Gravity alone, at any given point on the face of the earth, knows no faintest change, at any time. The force exerted by gravity on any object may conveniently be indicated with great accuracy. Hence gravity makes an ideal measuring medium.

Again, there's no likelihood of a stoppage in supply. If there ever should be, none of us would have to worry about the results; we wouldn't be here!

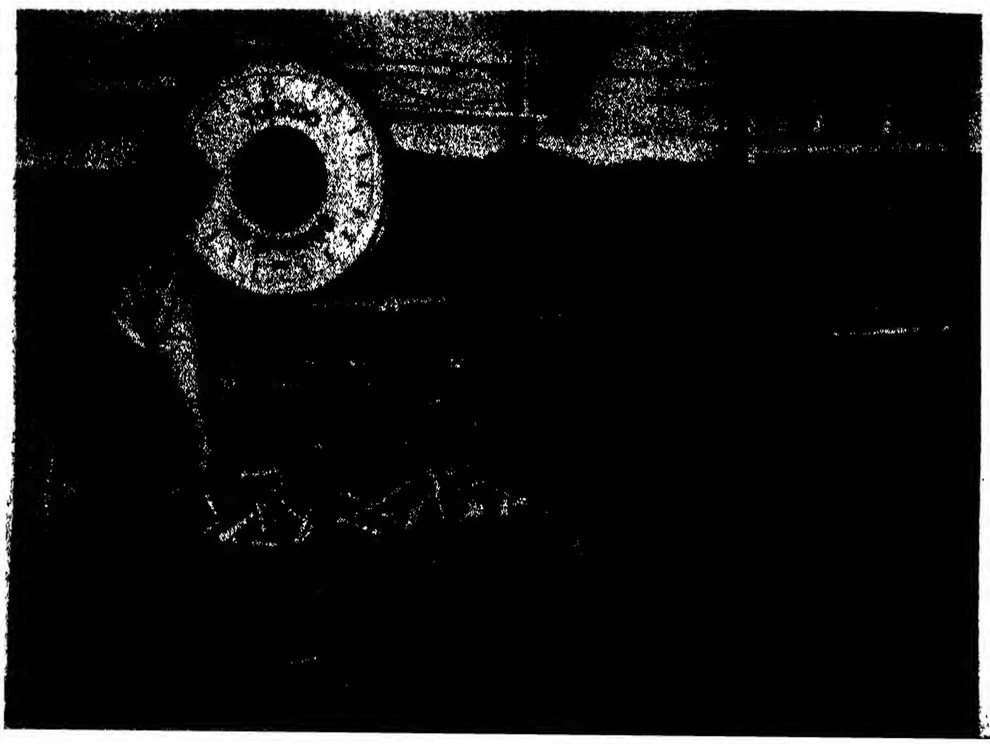
With these peculiar advantages, control by weight should logically have come into its own many years before this. But important applications of it were only possible after the development of the automatic scale. In the old days of steelyards and beam scales, when hand-setting was essential, there was no possibility of using control by weight in, for example, a fast-moving production line or process. The automatic scale, however, eliminated the human hand; as soon as a load came to its mechanism, it functioned instantly. It did not take alert engineers long to realize that here was a new and useful instrument.

Development of the automatic scale has been rapid; its uses are now innumerable. Yet it is only fair to say that the development of the "gravity motor" as a control and check is in its early stages. If whole factories ever are run by panel control from a central G. H. Q., it will be because clever applications of control by weight have made it possible. Indeed, at the last Chemical Show in New York, this futuristic picture was very plainly foreshadowed in the panel control display of one manufacturer.

THE principle of automatic weighing is applied today in industry in order to check quantity; to package and fill; to ascertain breakage, yardage, and moisture content; to count small parts; to check quality; to direct, supervise, and check mixing and batching. It is obvious that these functions fall into three general groups. The simplest includes such jobs as checking quantity and ascertaining breakage, yardage, and moisture content. The next is automatic packaging and filling. The most advanced is the automatic control and supervision of batching and mixing. More or less in a class by itself is the system of obtaining accurate printed records of many of these processes.

Note that few of these functions are those which one ordinarily thinks of as customary functions of a scale. Nor are they, in actual fact; the instrument which performs them is no longer a scale in the simple sense. It operates by gravity and it uses scale mechanics; but it does much more than weigh.

Matching of suspension springs for automobiles offers a good example of the expanding uses for scales. No mat-



Counting by weight. Bin in foreground is on scale platform; number of items in scale pan, multiplied by the scale reading, gives number of items in bin

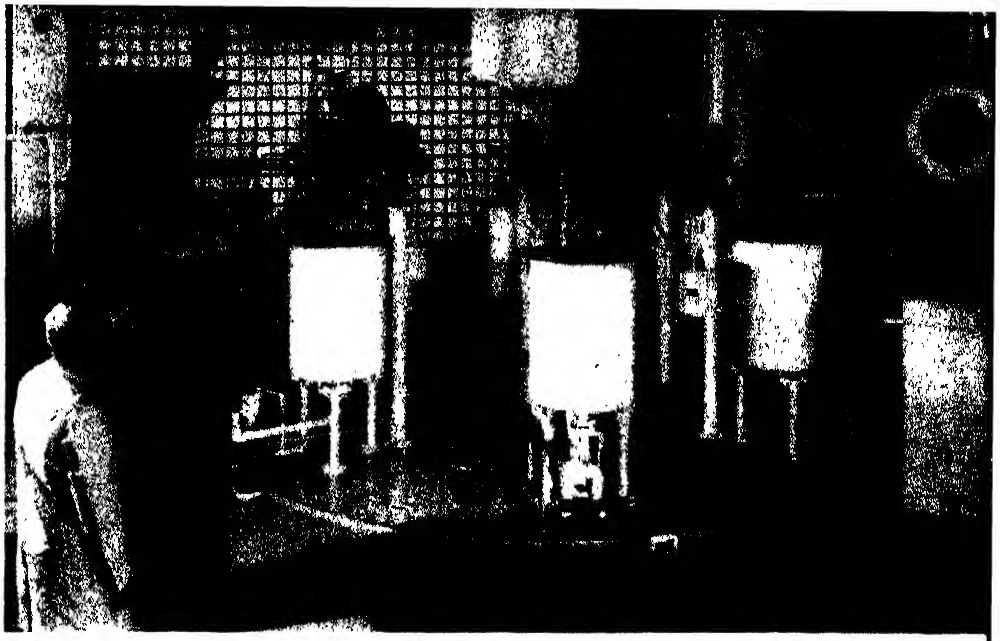
ter how careful the manufacture, men cannot produce a thousand springs of identical compression. There is bound to be a slight variation, and that variation is going to have bizarre and unfortunate results if a spring of strength-A goes on the forward left corner of your chassis, and a spring of strength-B goes on the rear right corner. It is not important that all springs be of the same strength; it is important, however, that all four springs on any given car be of identical strength.

It is possible, of course, to test each spring separately and sort them by human labor. But that's not the way the automotive industry grew up. Instead of that slow and unreliable method (human labor makes occasional errors), the industry now generally uses a spring sorting device which is actually a scale, plus. Fed into it automatically, the springs are compressed, their strength measured, and then ejected from the device in one of three classifications. Discharge takes place when the indexing table stops over the upper end of two spouts. Normally, the spouts are held in a vertical position, but when a spring registers weaker than the low-compression limit, one of them is actuated toward the left. Whenever a spring comes along that registers stronger than the upper tolerance limit, the same spout is actuated toward the right. Springs which fall within the compression requirements are ejected through another spout.

THE problem here was to measure rapidly and automatically a certain force, and then to sort out the articles measured. This application falls into the first grouping outlined above. It is really a checking of quality and quantity, plus a sorting operation. The same idea has been applied to matching pistons by balance, so that a car may have a full set of pistons that are mechanically identical and hence will work in harmony and with maximum efficiency.

Early applications of control by weight were in the manufacture of sand paper, roofing paper, tarred or proofed fabrics, and so on. The basic idea is that a continuous production line brings along a strip of the material to which must be applied a covering substance such as sand, tar, paint, ink, or gum. It is of vital importance that the flow of the covering substance remain constant, in order to insure uniform quality. This insurance is obtained by passing the production line over a bar or lever which is actually the platform of a scale. The scale, however, is of the "over-and-under" type; its face or chart, if indeed it has any at all, contains but three marks: a middle zero, a lower-limit tolerance to the left, and an upper-limit tolerance to the right. As long as the production line passes along in proper manner nothing happens. Should a section come along with too much or too little of the recently added material, the scale steps in and automatically actuates switches which stop the line.

Typical of batching installations is the use of scales in bakeries. Wholesale bakeries are among the greatest users of industrial scales in the United States. One of the most interesting of the recent bakery installations is that found in the Omar Baking Company in Indianapolis. Here a scale measures exactly and automatically the quantity of flour required for each batch. In the past the bakery had used beam-type equipment, and some difficulty had been encountered in maintaining the uniformity of batches. Uniformity is one of the most serious problems in a bakery; if the ingredients are not batched accurately, the batch may prove too moist when it reaches the dividers. As a result, unreasonable quantities of dusting flour must be added to correct this fault and to keep the loaves moving smoothly through the produc-



Cosmetic components are pre-weighed by the scales at right and in background. As tanks on revolving table reach indexed positions an exact quantity of material is injected into each one

Do More Than Weigh . . . Manufacturing Processes Automatically Controlled . . . Quantity and Quality Checked . . . Saving Time, Material, and Labor Costs

Pipe smokers are sure to get the correct amount of tobacco in each package filled in this room. Content weight is checked accurately by individual scales

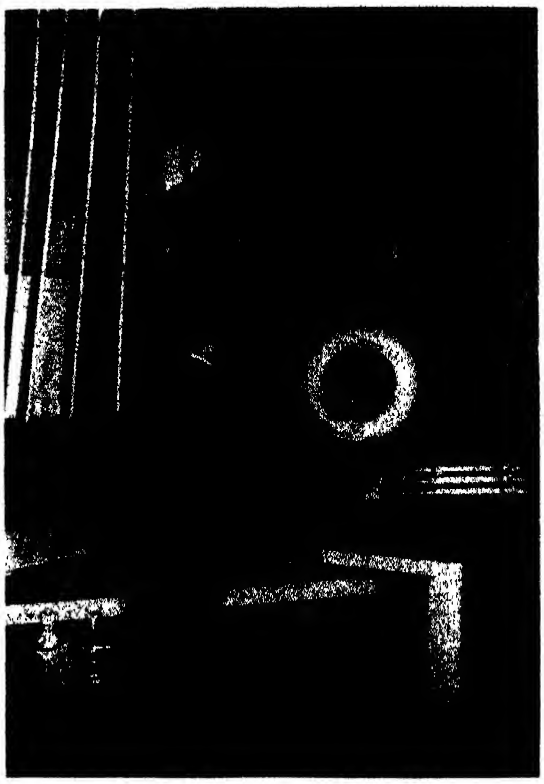
tion machinery—all of which involves problems of production, inventory control, and quality. The new installation permits positive control and rigid adherence to formula. The budget of material-required can now be checked with actual inventory to within a fraction of 1 percent. The hopper scale installed in this case is equipped with a 500-pound dial, and the photo-electric cut-off is of the single zero type.

In operation the flour is brought from two floors below by an endless-belt bucket-conveyor to a storage-hopper on the floor above the scale. When the operator pulls the starting-chain, a screw conveyor carries the flour to a point immediately above the weigh-hopper. When the predetermined amount is in the hopper, the photo-electric control instantly closes a clam-shell type cut-off above the hopper, and stops the screw conveyor, which stops the flow of the flour.

All weighing is done on a live-rail section above the center mixer. The load can then be discharged either into that mixer, or moved along the rails to any one of the mixers in the battery. Thus one scale weighs the flour for several mixers. The bakery officials have commented: "It will pay for itself several times each year."

INTERESTING features are incorporated in modern concrete batching plants. All units are electrically operated. All batch mixing operations can be controlled by one operator at a control panel located between two scales. An automatic signalling system warns the operator when the supply bins are filled. The feed of materials to supply bins and weigh-hoppers is electrically controlled. Batches are mixed on trucks, en route to the job.

Two scales of the hopper type automatically and accurately weigh up the cement, sand, and gravel going into each batch. They have an automatic cut-off device and a means of determining and compensating for moisture content. One scale weighs the cement; the other weighs the sand and gravel. The operator has only to set the scale at the predetermined weight and to press a button to start the flow of material into the weigh-hopper. The hopper is automatically shut off when the predetermined weight is reached. Pressing another button discharges the material into the batch-hopper. The process is simple and fast; the batch is exactly proportioned.



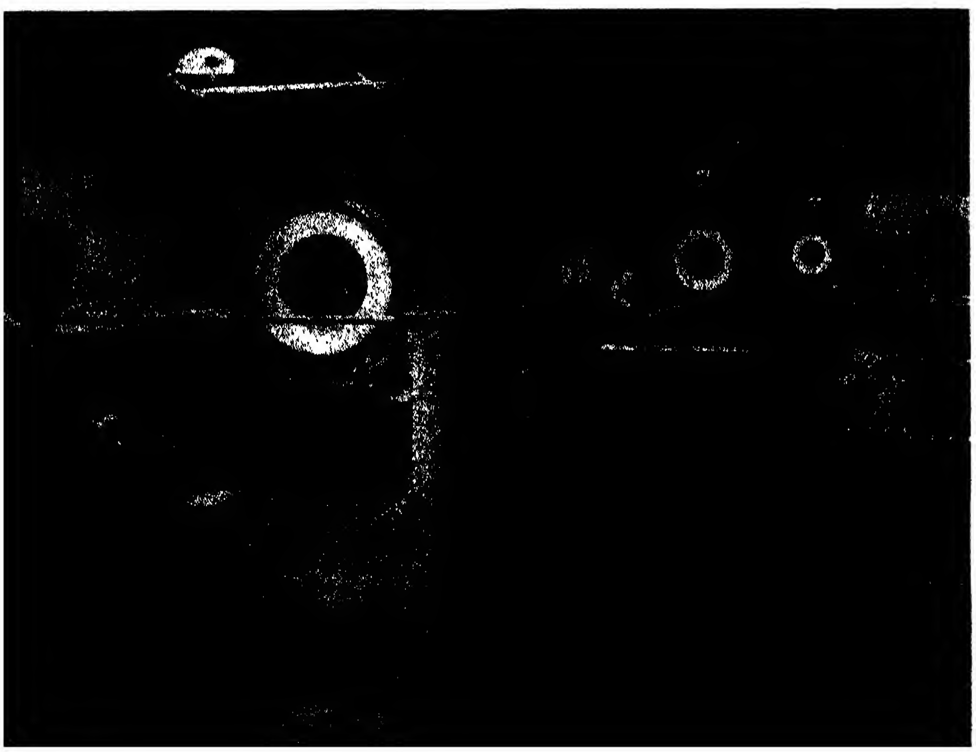
Quality of finished concrete is governed by accurate proportioning of materials. This long-beam scale batching equipment in a concrete mixing plant gives instant hair-breadth control

A thorough-going installation with many potential uses is the totalizing device which, applied to belt conveyors, controls amounts of materials going into a batch. It is in effect a flow meter for dry materials, automatically and continuously proportioning two or more such materials. In accuracy it functions down to something less than 0.13 of 1 percent.

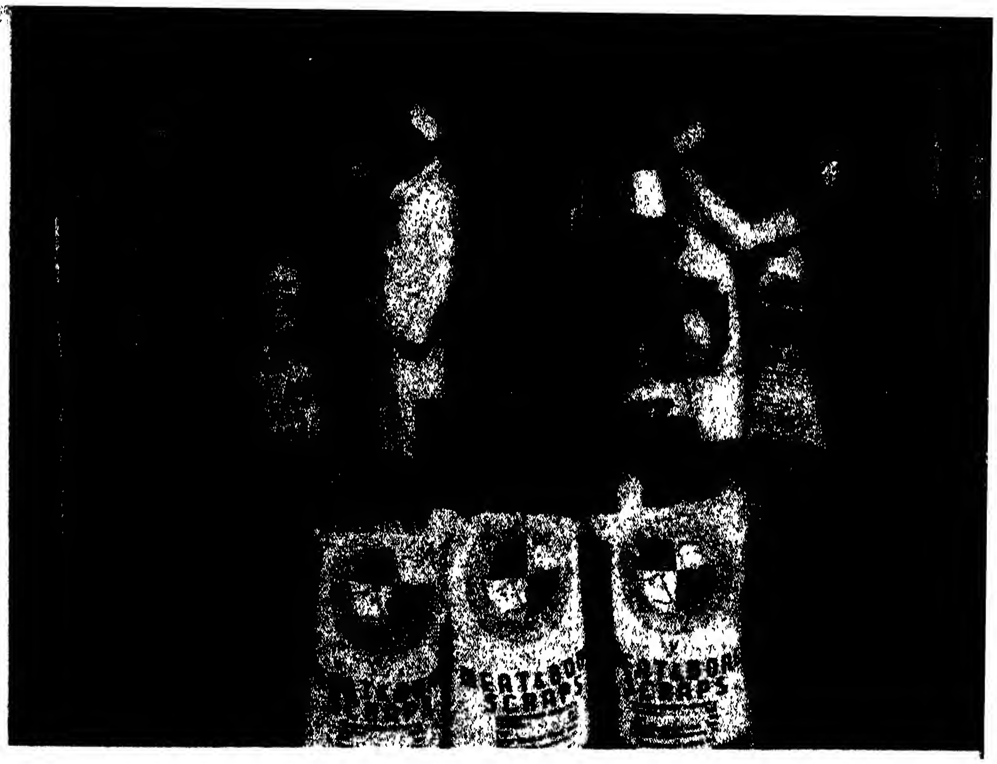
Two principal variables are involved: belt loading per unit of length, and rate of belt travel. A transmitter, part of the scale apparatus, sends instantaneously to the totalizer any variations in belt loading as accurately measured by the scale. Similarly, a belt-speed compensator detects any change in belt speed and projects them into the totalizer. The latter instrument automatically combines or multiplies the two variables and translates them to motion in the counter on the face of the totalizer unit. This unit is separate and can be located at any point remote from the operation. The installation as a whole has been highly perfected to take care of such bothersome factors as belt slippage, variable tare of the belt, and so on.

While the totalizer unit is described as handling dry materials on conveyor belts, an increasingly useful application is in the mixing of liquids. Colored inks, for example, are mixed by a weight-control device. In the control mechanism is a photo-electric cell, "watching" a scale dial. As the scale indicator passes before the cell, the circuit is closed, or closed and reopened, and any required compensating action is controlled.

One of the most thoroughly modern plants in the world is that of the Campana Company, in Illinois, where cosmetics are manufactured in exceptionally attractive and sanitary surroundings. Weight-control installations are used throughout the processes. The heart of this plant is the automatic control of the weighing, proportioning, batching, and mixing of the ingredients throughout production. The specifications covering Campana products are exacting; they require, in some instances, accuracy



Scales built into shipping room conveyors give a quick reading of the weight of outgoing shipments as the crates pass over a "live" platform



Bags can be hung, filled, and accurately weighed at the rate of eight bags per minute with this sacking equipment

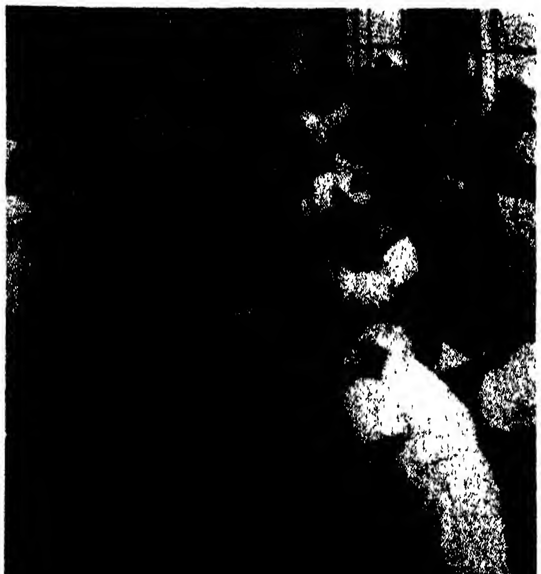
within the limits of 1/50th of 1 percent.

The first operation consists of accurately blending high-priced essential oils on a scale sensitive to 1/100th of an ounce. The exact amount of material is weighed out within a tolerance of 1/50th of 1 percent. The blended essential oils are then automatically proportioned and mixed with alcohol, to make a concentrate of specified consistency. This is done by means of a scale equipped with photo-electric cut-offs. This concentrate is then pumped to storage above another scale, where it is further batched with several other ingredients, all automatically controlled by weight. The processes are electrically interlocked so that diverting valves are opened or closed when necessary, agitators are started at the proper time, and each individual ingredient is weighed out within very close tolerance and in proper sequence.

This batching equipment is so designed that once the operator starts on a certain batch of material, each ingredient is automatically introduced in sequence, agitation takes place at the proper time intervals, and the batch must be completed before the operator can start another batch, either of the same or different material. Furthermore, temporary interruptions of electric service cannot disrupt these operations. When electric service is resumed after such an interruption, the sequence of batching operations proceeds automatically from the step at which it was stopped.

Following these pre-mix batching operations, batches are delivered to storage tanks from which they are automatically released for the further injection of other ingredients, agitation, milling, filtering, and additional processing operations.

A particularly ingenious method of handling and further processing these pre-mixed batches has been developed by the Campana engineers. A revolving table carrying glass-lined tanks is automatically indexed at definite intervals, 1/8 revolution at a time. Each tank is equipped with its own agitator. At each indexed position of the table, a tank receives an injection of new material, pre-weighed and discharged into it by scales equipped with photo-electric cut-offs.



Millions of egg whites are yearly distributed to large users. Here they are being canned and weighed in one operation through use of floor-type scales fitted with top-reading dials

THESE scales are interlocked electrically with each other and with the indexing and timing operations; each tank thus receives an exact pre-determined amount of material. Any deviation from the established cycle of operations stops everything. In this way, the exact amount of ingredients is injected at the right time and with exactly the right amount of uniform agitation.

From this first table, the materials are discharged into storage tanks near the ceiling of the floor below. From here they are automatically fed into tanks on another table, below, indexed for 1/8 revolution position. Here the materials automatically receive additional injections and agitation in accordance with pre-set times and quantities, controlled again by electrically operated scales. From the second table, the product is again discharged, from each tank in sequence, for bottling, packaging, and shipping.

There are many scale applications where a printed record is required or desirable, held in a roll, or in card or tab form as dictated by the needs of the situation. A result of this recording-scale feature has been the elimination of much argument as to weights delivered—an achievement of no mean value at receiving stations where farmers deliver milk or sloops deliver the day's catch of fish.

Counting by weight is, of course, a simple and established procedure in the handling of large quantities of small objects such as nuts, bolts, and so on. Equally simple is the seemingly complex job of measuring yardage in a bolt of cloth, or checking cases of liquor to determine breakage without opening the case. Simple though the method is, the saving in time, materials, and labor costs is very marked. Innumerable instances are seen throughout the chemical industry, particularly. Experience has shown that the pencilled and thumbed figures of foremen or checkers, no matter how conscientious, may be in error. Foremen get tired, scales do not.

The scale engineer of today is so much more than merely an engineer of scales that he really deserves a new title. He has become a practical, technical expert in material control. Quantity, quality, and manufacturing economy are his stock in trade.

Illustrations courtesy The Exact Weight Scale Company and Toledo Scale Company.

PROPERTIES OF MATTER

Unfamiliar Effects Produced by Pressures Up to More than Half a Million Pounds per Square Inch . . . Ice that Melts Only at 376 Degrees, Fahrenheit

AT least 99.80 percent of the material of the earth, and 99.99975 percent of the material of the Sun, exists under pressures greater than 1000 atmospheres—approximately 15,000 pounds per square inch. The importance of a knowledge of the effect produced by high pressures on the properties of matter, if we are to understand very deeply the construction of the physical universe, therefore hardly requires any argument.

For a number of years I have been studying in the laboratory various effects of high pressure on the properties of matter, and I am glad to accept the invitation of the Editor of the Scientific American to describe some of the results. Although the pressures with which we shall deal are all higher than 1000 atmospheres, and therefore are high by the standards of everyday life, they are nevertheless absolutely insignificant when compared with the pressures at the center of the earth or of the Sun. The highest pressure which up to now has been subject to laboratory control and accurate study is about 50,000 atmospheres; this is the pressure to be found in the crust of the earth at a depth of about 100 miles. About 92.5 percent of the material of the earth lies below a depth of 100 miles, so that our ignorance of earth conditions is still profound, but it is nevertheless significant to have got this 7.5 percent under some sort of laboratory control, when one reflects that before pressure studies were made only a negligible fraction, that is, the matter on the surface, was under such control.

SO persistently and successfully over a long period of years has the author of the accompanying article pursued his experimental researches in the special corner of physics dealt with that his name is linked with it in the minds of scientists and engineers the world over. In his book, "The Physics of High Pressure," also in over 70 published papers, he summarized his work up to 1931. Some of his later findings are now described here.

Prof. Bridgman is also widely known for his contributions to the philosophy of science—specifically the logic of modern physics—dealt with in his book, "The Nature of Physical Theory" (1926). He is a member of the National Academy of Sciences and of the American Philosophical Society.—*The Editor.*

THERE are a number of technical problems that must be solved before one can begin to make measurements in the laboratory, and we will stop for a brief preliminary look at some of them. The problem of preventing leak of the liquid with which pressure is transmitted is probably the first that naturally occurs to one, and it is certainly the first that one encounters in the laboratory. The early experimenters solved this problem to a certain degree by brute force—by making the packing as tight as possible with powerful screws. But such packings always leaked as soon as the pressure in the liquid reached the pressure which had been applied with the screw to the packing, and since a screw is a very imperfect means of getting high pressures, leak usually occurred at a few thousand atmospheres. The solution of this problem, as of so many others, was obtained by applying a little finesse and tact to the situation. It proved to be not difficult to modify the design of the glands retaining the packing so that the pressure itself should automatically always maintain the pressure in the packing higher than the pressure in the liquid that was trying to leak past. With such packings, leak becomes impossible until the pressure vessel itself breaks, and the problem was thereby transferred to building pressure vessels so strong that they would not burst.

Perhaps one's first impulse here is to think that the problem may be easily solved merely by making the vessel heavy enough, but actually it is not as simple as this. There is practically no advantage in making the walls of a pressure vessel thicker indefinitely, for the reason that nearly all the stress and strain is concentrated near the inside, so that additional thickness on the outside does practically no good. If, however, we could apply pressure to the *outside* of the vessel, then we could very much increase the pressure that could be carried by the inside. The trick is to make the pressure vessel in multiple units, one inside the other, internal pressure in one vessel being external pressure on the vessel inside it. In practice, one very convenient way of producing the external pressure on a vessel is to give it a slightly conical shape, and then to push it as hard as is safe into a conical sleeve, which it fits accurately. The action is the same as when we push a conical stopper tightly into the mouth of a bottle.

Another part of the problem is to produce the pressures, and this requires the action of some sort of piston. Steel is not strong enough for the piston, but most fortunately a new material has been recently developed, which for this purpose is about twice as strong as steel. This material is "Carboloy"; I am much indebted to the General Electric Company and particularly to Dr. Zay Jeffries for most generously supplying the Carboloy necessary for these experiments.

The force which drives the piston is best generated by a hydraulic press, which is very much more efficient than a screw. One may get an idea of the appearance of the apparatus from the illustrations.

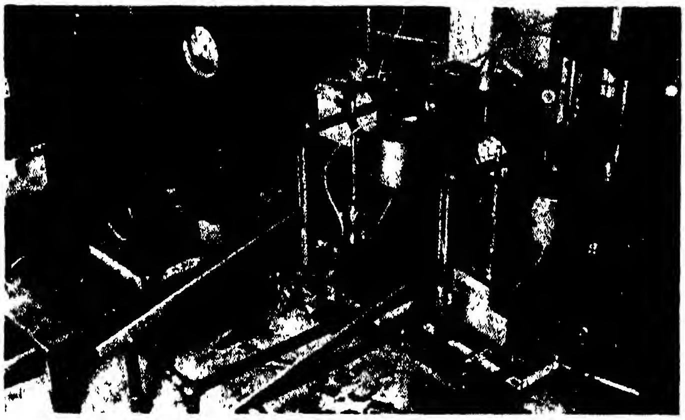
WE are now ready to discuss some of the effects produced by high pressure. One of the most interesting of such effects, and one which has a long history, is the change of melting temperature produced by pressure. When thermodynamics was still in its infancy, Lord Kelvin's brother, James Thomson, proved that the melting temperature should be raised by pressure if the substance expands when it melts, as do most substances, but if the substance is one of those abnormal ones which contract when they melt—of which the best known examples are water, bismuth, and gallium—then the melting temperature should be lowered by pressure. Lord Kelvin made a spectacular experimental demonstration of this prediction from thermodynamics of his brother. The experiment was difficult, however, because it was possible to produce a change of the freezing temperature of only a fraction of a degree with the pressures then available. But with the pressures now at our command it is possible to bring about large changes in melting temperature: the melting point of ordinary organic compounds may be raised by many hundred Centigrade degrees, and even a metal like mercury may be made to

UNDER HIGH PRESSURE

By P. W. BRIDGMAN
Professor of Physics at Harvard University

freeze solid at the temperature of boiling water under a pressure of about 28,000 atmospheres.

The situation presented by water has interesting features. What is to be expected if the pressure on water is raised indefinitely? Will the melting temperature drop indefinitely, or will something else happen? There was much theoretical speculation on this topic in the few decades after James Thomson's discovery, but the imagination of physicists did not prove equal to divining the true state of affairs. Tammann was the first experimenter who applied pressures as high as 3000 atmospheres in studying problems of this kind, and he found at once that something almost sensational happens. The melting temperature of ice continues to drop until a pressure of about 2200 atmospheres is reached, where the melting temperature is about —22 degrees, Centigrade, which is a trifle colder than can be reached with the most advantageous mixture of ice and salt in the old fashioned ice cream freezer. Now if a pressure greater than 2200 atmospheres is applied to our ice at a temperature lower than —22 degrees, Centigrade, the ice suddenly collapses, with a decrease of volume of 20 percent, and its molecules take up an entirely different crystalline arrangement, as has been proved by actual X-ray measurements by Dr. McFarlan. That is, ordinary ice, by the application of sufficiently high pressure, is made to undergo a "polymorphic transition" to a new crystal system. The loss of volume when this polymorphic transition occurs is so great that the new ice which replaces ordinary ice at higher pressures is denser than liquid water. Hence, if James Thomson's argument is sound, the melting temperature of this new ice should rise when pressure is increased on it, just like that of any normal substance. Experiment brilliantly confirms this prediction. The actual situation is, however, much more complicated than even this, because if too much pressure is applied to Tammann's new ice—3500 atmospheres, to be precise—it in turn becomes unstable and experiences a polymorphic transition with further decrease of volume, and from here on the melting temperature rises still more rapidly with increase of pressure. Even this is not all, for there are seven different kinds of ice in all which may be produced by high pressures. The last and most recently discovered kind of ice melts, under a pressure of 40,000 atmospheres, only at a temperature of 190 degrees, Centigrade—considerably above the temperature of melting solder.



The double hydraulic press, at the right, with the three hand pumps (note their three levers) that are used in its operation

Reasoning by analogy, one would expect that the other two substances, namely, bismuth and gallium, which expand like water when they freeze, would also presently have polymorphic transitions, and that the melting temperature would eventually rise. For a good many years search was made for this suspected phenomenon, especially in the case of bismuth, but with negative results. It finally turned out that the difficulty was merely that the pressure was not high enough. Recently I have found that, by applying 25,000 atmospheres to bismuth and 13,000 to gallium, the long suspected transitions may be made to occur. At pressures beyond these the melting temperature of these substances also rises with further increase of pressure. It appears then that the abnormal expansion on freezing of water and these other substances is only a temporary and somewhat accidental phenomenon; it is probable that at high pressures all substances contract when they freeze. Nevertheless, the expansion of water when it freezes is enormously important for the biological organization of the world in which we live.

The polymorphic transition which turns the abnormal forms of water, bismuth, and gallium into other forms proves to be a very widespread phenomenon at high pressures, and I have studied altogether some 100 different examples among elements, inorganic and organic compounds. Many substances have more than merely two polymorphic forms: thus water has seven, bismuth four, and gallium three. The record is at present held by camphor, which has certainly nine, and probably eleven, different modifications.

Polymorphic transitions must be of very frequent occurrence under the conditions of high pressure and temperature prevailing in the crust of the earth, and we must expect new forms differing in their properties from the familiar forms. This means that one can never feel secure in his geological speculations about conditions in the earth's crust unless he has positive knowledge that a polymorphic transition has not vitiated his analysis, and emphasizes the importance of studying in the laboratory materials under the actual conditions to which they are exposed in the crust.

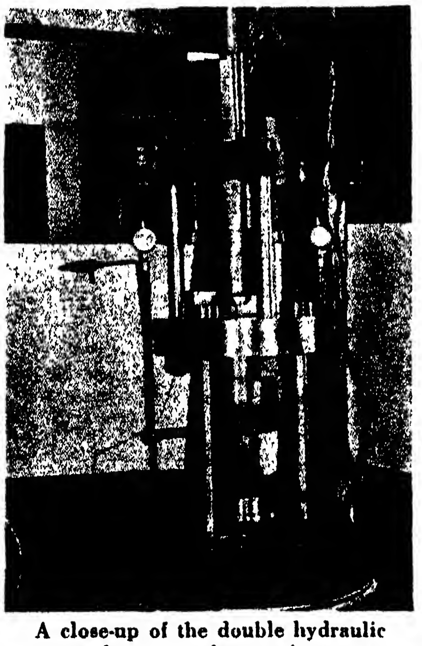
ALL these polymorphic transitions which we have been discussing are similar to the melting of water, in that when pressure is removed the material reverts to its original form. That is, these transitions are reversible, and do not involve permanent changes. A single isolated example has been found, however, of a permanent, irreversible change produced by pressure. Ordinary white phosphorus which, as everyone knows, is so unstable chemically that it catches fire spontaneously when exposed to air, is permanently altered by high pressure and temperature to a new form, previously unknown under any conditions. This new form does not catch fire in the air, is black instead of white, and is a conductor of electricity instead of an insulator. Black phosphorus is much like graphite in appearance. The subject of the mutual relations of all the modifications of phosphorus is not very well understood and is complicated; recently Dr. Jacobs has found another kind of black phosphorus which is more active chemically than the other form.

A permanent alteration like this

kindles the imagination; one wonders whether it is not possible to alter permanently other materials by the application of sufficiently high pressure, and produce a multitude of brand new substances, some of them perhaps with important commercial properties. It is not inconceivable that diamond may be another transformed element of this kind, in the formation of which high pressure may be a vital factor. But, just as in the case of black phosphorus, temperature is also probably an essential factor. The fact that no one has yet succeeded in producing diamonds artificially, at least in commercial amounts, may be because high enough pressures and temperatures have not been used in combination. It is known that 100,000 atmospheres at room temperature is not adequate. The whole subject is one on which some sort of theoretical enlightenment would be most desirable; we would like to know in advance whether other such transformations are possible, and if so among what substances, and what pressures and temperatures are necessary. But at present the prediction of changes like this appears to be even more difficult than the prediction of ordinary reversible polymorphic transitions.

NEXT in simplicity and ease of measurement after polymorphic transitions are mere changes of volume. One is of course sufficiently familiar with the compression of a gas into a small volume when pressure is exerted on it, as dramatically demonstrated by the air that rushes out of one's tire when one has a puncture, but the compression of liquids and solids is not so evident or so readily demonstrated. This has led to sometimes fantastic popular ideas about the absolute incompressibility of liquids like water, ideas which were supported by early crude experiments by physicists, as in the celebrated experiments by the Florentine Academy at the time of Galileo. Nevertheless, both solids and liquids, as well as gases, are compressible; the difference is merely one of degree, requiring much more delicate apparatus to disclose it. In fact, it was not until about 175 years ago that the compressibility of water was demonstrated by placing it in a vessel provided with a very narrow capillary, like a large thermometer, with which the changes of volume could be sufficiently magnified.

It is even more difficult to demonstrate the compressibility of solids; iron, for example is 100 times less compressible than water, and it was only much later in the development of physics that adequate means were found for measuring the compressibility of such substances. However, when pressures of thousands of atmospheres become available, the volume changes of liquids and solids become large enough to be accurately measured with comparatively simple means. Liquids may lose 30 or 40 percent of their volume. Of course every liquid eventually freezes to the solid when pressure is applied to it, no matter how high the temperature, so that measurements on liquids are eventually terminated by the liquid turning into the solid, and measurements of compression have to be continued at high pressures on the solid. Thus, the volume of ice at room temperature at 50,000 atmospheres is found to be only 60 percent of the volume of the water with which the experiment started. Metals are in general much less compressible than liquids, but there is a great deal of variation, and the most compressible metal, caesium, is more compressible even than ordinary liquids, and may be reduced to less than one half its initial volume by a pressure of 50,000 atmospheres.



A close-up of the double hydraulic press shown on the previous page

Two stages are to be recognized in the compression of a liquid and to a less extent in the compression of a solid. At first, while the pressure is low, the compressibility is comparatively high; this is followed at higher pressures by a relatively extended range of lower compressibility. The first stage is due to squeezing the atoms or molecules into tighter contact—"taking out the slack" from the atomic structure. The second more extended phase is due to more deep-seated changes which may affect the constitution of the atoms and molecules themselves. The first stage can be understood with the stock of older ideas which was adequate to explain the relations between liquids and gases, but to understand the more deep-seated alterations it is necessary to use some of the newer ideas of quantum theory. It is easy to imagine that a rigorous solution of the problem of the behavior of any body composed of parts as numerous as the atoms in an ordinary body is of prohibitive complexity, and that approximations must be invented. The approximations are of different kinds for different sorts of body, and have been worked out in detail only for the simplest. It turns out that the situation is particularly simple for caesium, and for others of the alkali metals. The structure of caesium consists mainly of positively charged cores of atoms embedded in what is effectively a uniform jelly of negative electricity; the uniformity of the jelly arises from the fact that the negative electricity is in incessant motion. This motion of negative electricity is something of which we had no adequate conception before the advent of wave mechanics, and our recognition of it constitutes one of the great advances of the last few years in our understanding of the construction of ordinary bodies. The speed of motion of the negative electricity is found to depend on the space which it occupies; like a crowd of insects the electrons buzz about more angrily the narrower the space in which they are confined. Here is to be found the explanation of the resistance to compression offered by substances like caesium: when such a substance is compressed the electrons buzz about with greater velocity and therefore greater energy. It is the work done by pressure in overcoming the resistance to compression that supplies this increase of energy of the electrons. On the basis of this sort of picture it proves to be possible to calculate the compressibility of substances like caesium, and Dr. John Bardeen at Harvard recently has succeeded in making calculations which agree surprisingly well with the experiments. Similar calculations will eventually give an understanding of polymorphic transitions.

MANY other changes in the properties of bodies are produced by pressure which there is not space to discuss here. One only may be mentioned—electrical resistance. The electrical resistance of the majority of substances decreases under pressure. Some substances, which under normal conditions are not very good conductors, like tellurium or silver sulfide, may be made by high pressures to conduct thousands of times as well as normally. On the other hand, there are a number of substances which are made poorer electrical conductors by pressure, and there are more complicated instances which combine both sorts of behavior. It is most gratifying that the picture of the structure of metals which wave mechanics is developing is proving adequate to explain the broad features of the complicated experimental situation, and we may anticipate even more success when more powerful mathematical methods have been worked out.

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

CHLORINATED RUBBER RUST-PROOFS STEEL

RECENT extensive tests under severe corrosion conditions have shown the high value of paints made with a chlorinated rubber base as an undercoat on steelwork. Paints of this type dry rapidly to form films resistant to acids, alkalies, and other corrosive agents. Applied directly to metal, this highly resistant film adheres well and prevents contact with corroding agents.—*D. H. K.*

LARGEST QUARTZ CRYSTAL

ONE of the largest and finest quartz crystals ever to enter the United States went into the vaults of the Bausch & Lomb Optical Company recently. Coming from the Province of Minas Geraes, Brazil, where it was brought by mule pack from the diamond section of the Serra da Mantiqueira range, 1500 miles from the coast, the huge crystal weighs 63 pounds and cost $18 per pound. Based on optical quality, experts believe that it surpasses any museum piece of this type in the country.

Although quartz, a form of silica occurring in hexagonal crystals, is distributed throughout the world, no deposits of suitable optical quality have been found in the United States. Brazil is the chief source of supply.

Revealing the geometrical form of the huge quartz crystal described

The crystal is solid matter in its most perfectly developed and naturally organized condition. Its exterior is characterized by a form of extraordinarily regular geometrical design. The internal structure is, likewise, so regular that the arrangement of the structural units, or chemical molecules, is precisely the same about one point as every other point.

Measuring the quartz crystal prior to cutting it for commercial use

Biologists, cytologists, and histologists benefit by the use of quartz accessories for the microscope because of the ability to differentiate better between various cell and tissue structures, while the spectroscopist utilizes quartz instruments in detecting various elements whose identifying lines lie in the ultra-violet portion of the spectrum.

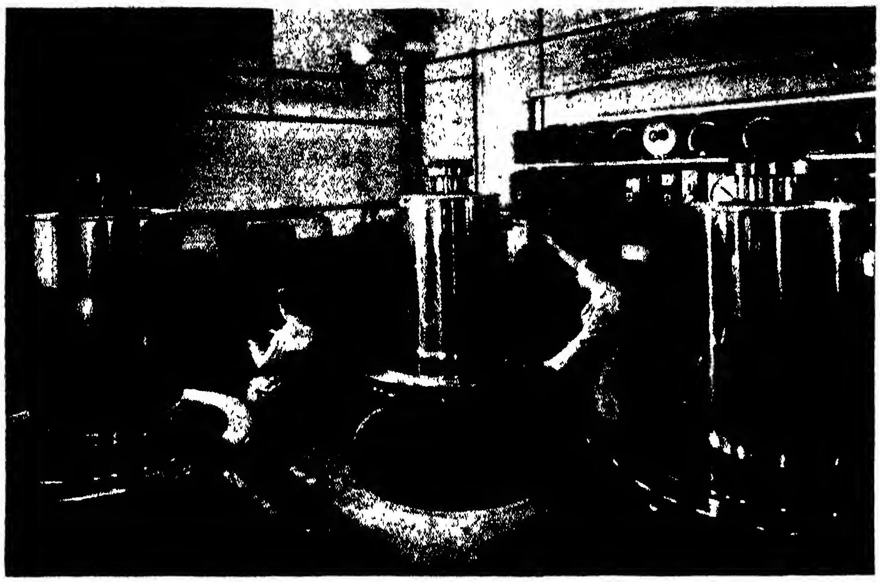
FLAME TAILORING

AFTER 10 years of intensive and literal playing with fire, engineers in General Electric's air-conditioning laboratory believe that they have tamed the unruly flame of the oil burner. Indication of their complete satisfaction is found in the fact that for the first time the company is placing on the market the device it began to investigate a decade ago—an oil burner for installation in existent furnaces, operating at low pressure and with a clear, quiet flame that can actually be tailored to fit the combustion chamber of most furnaces.

In spite of the fact that a million and a half home owners have installed oil burners, the inherent difficulty of proper installation, resulting from lack of co-ordination between burner and the many types of existing furnaces, has always been recognized by heating engineers. Inefficiency too often resulted when oil was adopted as fuel for a heating system that had been designed for another method of firing, although the resulting convenience and cleanliness of the oil burner were undeniable. Expensive complications in wiring the burner-to-boiler controls, and nozzles worn by the high pressure needed to atomize oil mechanically, accounted for some dissatisfaction. But more often the trouble has been inherent in the fact that the flame produced by the burner did not fit the combustion chamber, and air pressure had to be distorted to make it fit, lowering the unit's efficiency.

Both the motor-compressor unit and the controls of the new burner—almost human in their vigilance—are identical with those used in the G-E oil furnace. Operation of the device at from 8 to 15 pounds pressure results in quiet operation and indirectly in fuel economy, since the use of compressed-air atomization enables the burner to employ an unusually large atomizing orifice.

The type of oil-burner flame now obtainable through flame tailoring



Three newly completed "creep" recording machines. See also cover illustration

The larger orifice does not become clogged easily, the nozzle is not worn away by oil at high pressure, and the compressed air cools the nozzle and prevents carbonization. All of which means fewer service calls.

Incorporated in the new burner is a fast-action flame detector, a safety device which automatically shuts off flow of the oil-air mixture, unless a flame is propagated within five seconds after the electric arc ignition is applied. In case of flame failure at any time during operation, the flame detector cuts off the flow of mixture and the controls re-cycle. If no flame appears after two attempts at combustion, the two-try re-start device automatically shuts down the burner completely.

A high-pressure fan minimizes the effect of draft variation, causing the burner to operate efficiently with less dependence on the chimney for proper draft. And a high-lift pump will draw oil from a tank as much as 15 feet below the burner, eliminating the cost of an auxiliary pump.

Electric Furnaces for Metal Testing

The finishing touches have just been added to the third of a battery of unique electric furnaces by means of which engineers at the Westinghouse Research Laboratories will study the "creep" of steel and metal alloys. The three new testing machines comprise the most elaborate creep-testing apparatus in the world. (See also the cover illustration of this issue.)

Before a piece of metal can be safely used in a modern high-speed machine, such as a steam turbine, engineers must know exactly how much it will stretch, or "creep," under working conditions. For example, the steam inside a turbine is so hot at 850 degrees, Fahrenheit, that the steel interior glows a dull red. Under the combined action of high temperature, centrifugal force, and steam impact, the grains in the metal slide; the blades creep. Turbine blades are made of alloys which will resist creep, and thus prevent collision after a few years' use, because blades are spaced only a few thousandths of an inch apart to operate efficiently.

Mr. P. G. McVetty, designer of the new testing apparatus, in effect, has combined 60 creep machines into a single unit. With all three of the new machines in operation, it will be possible to conduct 180 simultaneous tests. Each machine is a heavy alloy-steel block housed in a three-walled cylinder taller than a man and supported on a foundation of sand. In order to retain the heat inside the furnace, the outer shell is made of concentric sheets of polished nickel and aluminum separated by powdered silocel.

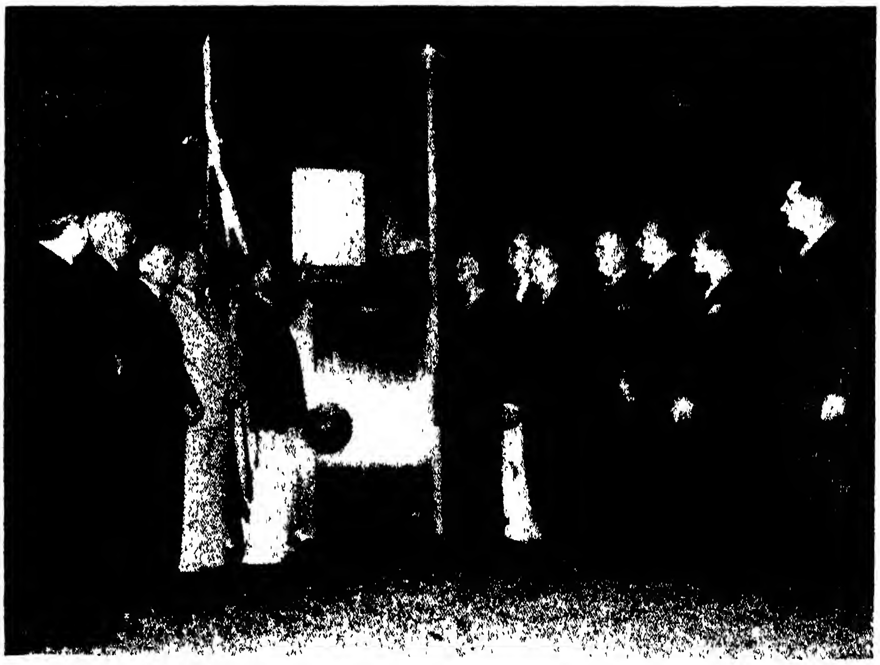
Sand was used in the six-foot-deep foundation pit because of its ability to minimize the effects of vibration which are known to hasten the creep of metals.

Three electric windings on the metal core of the furnace produce temperatures up to 1000 degrees, Fahrenheit, and a photoelectric cell maintains the temperature within 10 degrees or less by automatically operating a resistance which controls the electric current. The cylinder revolves once an hour in order to distribute the heat equally to all parts of the furnace.

When all three units are in operation, the operator will be able to "plug in" by means of a telephone switchboard and determine exactly how the heat is being distributed inside the furnace. One hundred and twenty-five pairs of wires will connect thermocouples in the furnaces with instruments for measuring and recording the temperatures.

Each heating core has 12 spaces for holding twelve 20-inch test samples which may be subdivided into five sections to make 60 tests. Dial gages connected with comparison rods extending through the top of the furnace measure the relative vertical displacement of the rods by the samples which may be "loaded" by weights and levers to carry 50,000 pounds per square inch of metal under test.

For a double check, Mr. McVetty equipped the machine with a circular track and a micrometer microscope called an "extensometer." A technician welds two platinum spots or targets at the top and bottom of the sample metal, scratches very fine lines

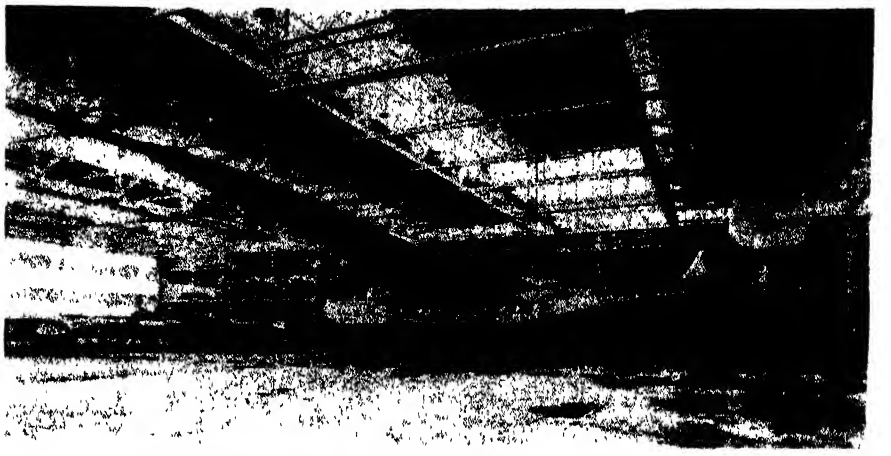


As pointed out in our editorial in July, Oglethorpe University's Crypt of Civilization, in which is to be sealed a complete record of our present civilization for the benefit of a far distant one, has been progressing rapidly. Here we show the scene at the recent dedication of the handsome stainless steel crypt door which has been presented by The American Rolling Mill Company. From left to right: Dean Raimundo de Ovies and C. M. Broome, both of Atlanta; T. K. Peters, Director of Archives at Oglethorpe; David Sarnoff, president of Radio Corporation of America; Dr. Thornwell Jacobs, president of Oglethorpe; Bennett Chapple, vice president of The American Rolling Mill Company; James Adams Colby, director of Roger Williams University; James B. Murphy, Director of the Division of Cancer Research, Rockefeller Institute; J. O. La Gorce, vice president of the National Geographic Society; J. Robert Rubin, vice president and general counsel for Metro-Goldwyn-Mayer, Inc.; F. D. McHugh, of Scientific American; and Colin English, Supt. of Public Instruction of the State of Florida. This crypt will probably be permanently sealed in about two years

on the spots, and fastens the sample metal in the furnace. When it is time to take a measurement of the creep, the cylindrical shell is revolved until the sample is opposite two quartz windows which pierce the 10½ inch wall. The microscope is rolled in place on the track, peers through the quartz windows and measures the distance between the two platinum targets. Its measurements are within one one-hundred-thousandth of an inch of perfection.

HELIUM

THERE are now in sight 25 billion cubic feet of helium in developed gas fields in the United States, or enough to inflate to capacity 3575 dirigibles of the size of the LZ-130. Other gas fields unquestionably hold additional supplies.



Huge planes require correspondingly large factory facilities

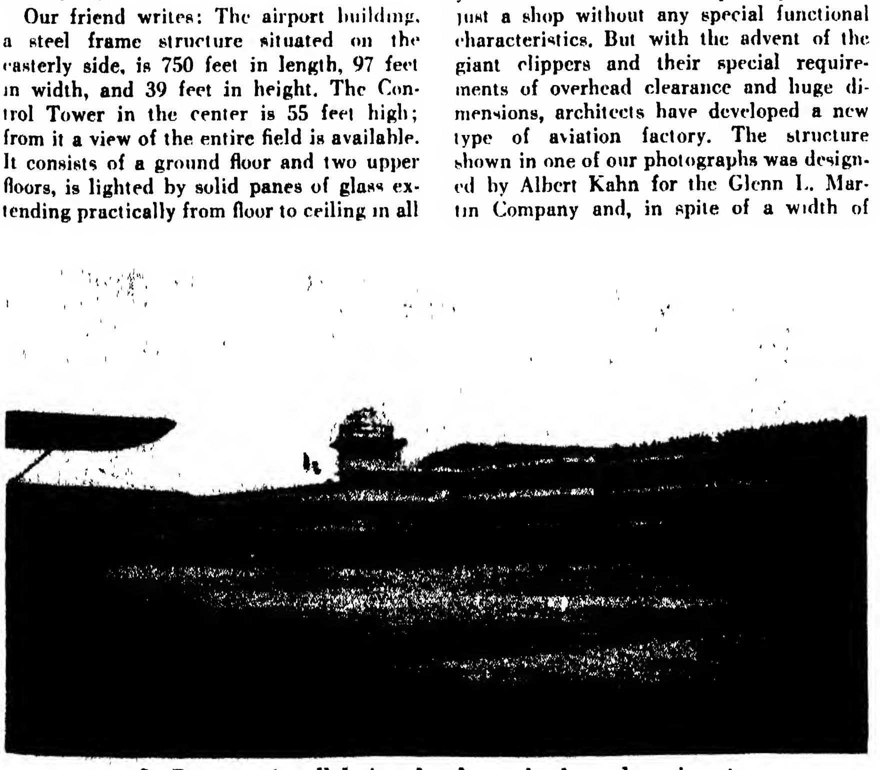
Le Bourget

IT is the fashion to say that France is in the throes of fatal civil disorder; that, menaced by a powerful neighbor, it is incapable of building up its military aviation; that, in general, France is going rapidly to the dogs; that nothing can save this beautiful country.

This fashion has appeared off and on for 50 years; somehow or other the French manage to survive and to unite solidly when the need becomes sufficiently pressing. In the meantime, in spite of all their troubles, the French do some remarkable work in many fields. A personal friend, R. C. Wood, of Paris, sends us first-hand information on the latest developments at Le Bourget, the Paris airport. For the first six months of 1937, Air France carried 83,000 passengers. The Le Bourget Airport has been rebuilt and considerably extended to meet the ever-increasing air travel. Government subsidies have actually been decreased, which is welcome news.

Our friend writes: The airport building, a steel frame structure situated on the easterly side, is 750 feet in length, 97 feet in width, and 39 feet in height. The Control Tower in the center is 55 feet high; from it a view of the entire field is available. It consists of a ground floor and two upper floors, is lighted by solid panes of glass extending practically from floor to ceiling in all rooms. Each of the floors fronting on the airport is set back so as to give a small terrace on which people can sit (and enjoy refreshments), while the roof is constructed to accommodate some 3000 persons. The offices of the Commandant of the Airport are provided with every possible means of control and aid to navigation. There are hotel rooms, complete restaurants, and so on. Provision is to be made for transatlantic air traffic later on.

When we think of the bleak looking fields, ugly buildings, hot-dog stands, and poor lunch rooms of some of our own airports, we might do well to remember that the French (and the English and Germans, for that matter) are giving their main airports the attractiveness and even the magnificence which modern aviation thoroughly deserves.—*A. K.*



Le Bourget: A well-designed and completely modern airport

Plants to Keep Pace with Clippers

THE Wright Brothers built their first airplane in a bicycle shop. For 20 years after that time an airplane plant was just a shop without any special functional characteristics. But with the advent of the giant clippers and their special requirements of overhead clearance and huge dimensions, architects have developed a new type of aviation factory. The structure shown in one of our photographs was designed by Albert Kahn for the Glenn L. Martin Company and, in spite of a width of 300 feet and a length of 450 feet, has not a single interior column. The height from the floor to the underside of the roof trusses is 43 feet. The entrance at one end of the building consists of a door having a clear opening 300 feet in width and 40 feet in height. To eliminate any obstructions in the interior of the building, the heating and ventilating system is installed underground. All electrical and mechancial conduits are also placed underground as a further means of eliminating obstructions. We do not believe that any other American industry calls for such special characteristics in its factories.—*A. K.*

Encouragement of Private Flying

PRIVATE fliers have long complained that air-traffic regulations have become too complex and that the main concern of the Department of Commerce is with the scheduled airline operator. They will draw hope from the announcement that a section for the encouragement of private flying has been established in the Bureau of Air Commerce. The Chief of the new section is being selected, and is to be a man thoroughly familiar with the problems involved.—*A. K.*

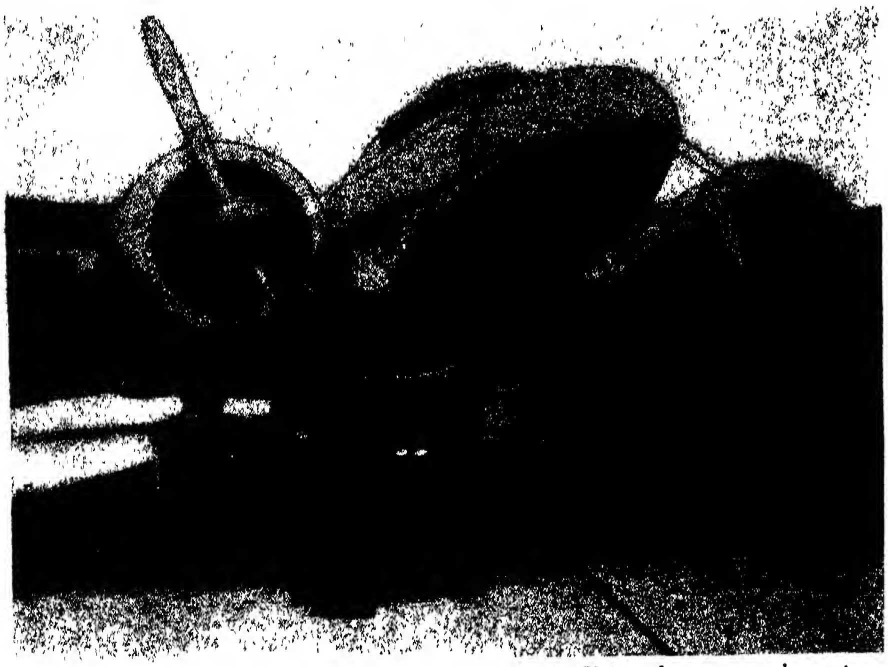
Flying Blind in Formation

IT is necessary in air tactics that a group of airplanes flying in formation shall arrive at their destination in approximately the same relationship to one another. Otherwise the tactical benefits of formation flying are completely lost. The question arises: Can a formation flight be maintained in conditions of exceedingly low visibility; that is to say, in flying blind?

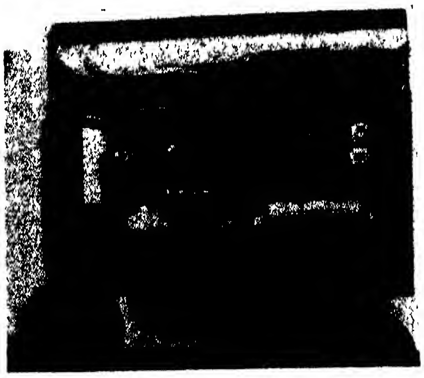
A recent flight by the 11th Bombardment Squadron of the Army Air Corps shows that it can be done.

A flight of three bombers took off from Hamilton Field, California, headed for Bakersfield, California. The Army men climbed to an altitude of 3500 feet in the vicinity of Mt. Diablo. Then visibility ahead became nearly zero.

The Commander of the flight issued radio orders that an altitude of 8500 feet was to be sought. If visibility was still bad at this altitude, then the overcast front was to be penetrated. At 8500 feet visibility remained as bad as ever. Just before the front was



Above: Using the new equipment for testing airplane instruments without removing them from the plane. *Below:* "Power plant" in the interior of the portable testing unit



penetrated, the navigator took the drift of 10 degrees and changed the compass course accordingly. Then, boldly, all three ships sailed into the blind front, with speed reduced to 135 miles per hour owing to icing conditions. Throughout the flight violent snow and rain squalls broke wing antennas and generally interfered with radio communication. The de-icers kept the wings free of ice, but on the Commander's ship it was found necessary to open the navigator's hatch and hit the front antenna mast in order to free it of ice. Nevertheless, on arrival at Bakersfield, after an hour and thirty minutes of flying, the planes were in sight of one another and only three miles apart. Such a formation flight, with reliance solely on instruments and radio, in zero visibility, aggravated by snow and rain, would have been unbelievable only a few years back.—*A. K.*

Testing Airplane Instruments in the Field

When a pilot on landing reports the poor functioning of any of his instruments, it is customary to remove such instruments from the cockpit to the laboratory, check them, and then return them or retain them for repair as the case may be. Such removal and replacement of the expensive and delicate instruments of modern aviation involves delay as well as appreciable wear and tear.

Now the Matériel Division of the Army Air Corps has developed a portable instrument laboratory consisting of a cabinet approximately 30 inches long, 20 inches wide, and 32 inches high, mounted upon three wheels. The equipment includes vacuum and pressure pumps, instruments for checking tachometer speeds, electrical cables, flexible cables, and so on. Master instruments mounted on the top of a panel in the cabinet include a thermocouple tester, pressure gage tester, and an altimeter tester.

As at present designed, the field test unit can check the accuracy of air-speed indicators, bank and turn indicators, flight indicators, fuel pressure gages, manifold pressure gages, oil pressure gages, rate-of-climb indicators, tachometers, turn indicators, and other devices which help the pilot so much but also serve to make his life such a complicated one.—*A. K.*

PETROLEUM CHEMISTRY

Two billion barrels of crude petroleum were saved to the world in 1937 by the chemical process of cracking heavy crude oil. Without this process the world would have required four billion barrels of oil to make the necessary gasoline, whereas the world production was only about two billion.

To Avoid Collisions

A suggestion in regard to aircraft safety from such a man as Lieutenant Richard Aldworth, distinguished war pilot with many years of practical experience in aviation and now Manager of the New York Airport, is always worth considering. He proposes the development of an instrument or instruments that will give the direction and distance from one aircraft to another while in flight. Of course it is always easier to suggest a device than to develop one. The difficulties in this instance are very great. Should research be in short-wave radio with reflection of waves from one aircraft to another? Should acoustic reflection be employed? Or sighting and triangulation by two mirrors placed some distance apart? It would be interesting to hear from readers what line of attack they would suggest.—*A. K.*

Plane Detection by Television

In the preceding note we asked for suggestions for the measurement of the distance of one aircraft from another. Perhaps a device now being developed by R.C.A. will some day make possible just such measurements.

Quite accidentally the British have made the discovery that the metal structure of an airplane in flight collects and re-radiates or reflects the ultra-short-wave impulses employed in television broadcasting, so that receiving sets produce a double or "shadow" image. The "shadow" image is formed by the waves which reach the television receiver direct and by those which rebound from the plane flying within range. The shadow is comparable with the shadow images caused in such sets by waves reflected from the Heaviside layer.

Again it was also discovered, still by accident, that the width of the shadow image cast by the airplane reflections bears a definite relationship to the distance of the plane from the television receiver.

From this it was but a step to experiments in airplane detection on the basis of this curious phenomenon. The British Air Ministry has established a number of television receivers which utilize this principle combined with the elementary principles of triangulation and may lead to a new system of plane detection far more sensitive and accurate than any of the acoustical methods available to date.

Then why not employ the same principle in the device proposed by Richard Aldworth?—*A. K.*

Bright Nickel Plating

Savings of from 25 to 50 percent in the cost of nickel plating are claimed for a recently developed "bright nickel" process which eliminates nearly all of the buffing, "tumbling," and coloring operations usually necessary to give nickel coating the proper luster before applying the final chromium plating. The new solution also eliminates buffing the copper base on which the nickel finish is applied and secures bright nickel deposits in deep, inaccessible places in complicated shapes otherwise expensive to finish.

Alcohol Protects Against Trichinosis

For protection against trichinosis, take a drink of beer, wine, or other alcoholic beverage with your hot dog, hamburger, or other meat that might harbor the larvae that cause this serious ailment.

The alcohol will keep the larvae, called trichinae, from burrowing into the walls of the digestive tract, Drs. James B. McNaught and G. N. Pierce, Jr., of Stanford University

School of Medicine, told members of the American Society of Clinical Pathologists at their most recent meeting.

Trichinosis is surprisingly widespread in the United States, recent surveys have shown. The disease is acquired by eating meat, usually pork, containing the trichinae. Thorough cooking kills the trichinae and makes the meat safe.

Alcohol does not kill the larvae, the Stanford scientists found. However, a single dose of alcohol given to rats simultaneously with trichinous meat gave 80 percent protection against the disease. The alcohol cuts down the number of trichinae larvae developing in the rat muscles and reduces the severity of the infection.

Alcohol, the studies showed, is no good as a treatment for the disease, only as a preventive.—Copyright, 1938 by *Science Service.*

Drying Air for Air Conditioning

ALTHOUGH air conditioning to the average person consists principally in cooling the air, drying it is probably more important. Among the materials successfully used to dry air for air-conditioning purposes is activated alumina, which has the ability to absorb large quantities of moisture. In use, the absorbent becomes saturated with moisture and must be revivified by heating. In many cases this method of air conditioning is more economical than de-humidification by cold alone.—*D. H. K.*

LOCOMOTIVE

WHAT is believed to be the longest continuous run by a steam locomotive in regular passenger service was made by Engine No. 3461 of the Sante Fe recently on the run from Los Angeles to Chicago, 2227 miles at an average speed of 45 miles an hour.

Submarine Telescope

INTERESTING and educational views of marine life are possible with a new under-water telescope recently placed on the market by the Boyce-Meier Equipment Company. A boatman can see exactly what has fouled his propeller or locate objects lost overboard, or can observe under-water hull shapes in the study of the design and construction of water craft.

The new device is similar in appearance to an ordinary megaphone except for the lenses. In the larger end is a water-tight porthole of glass, while in the smaller is an adjustable telescope. When in use, the larger end is held under the water and the scene is viewed through the lenses at the smaller, dry end. Magnification is about 3½ in air, and about 3½ to 4½ in water.

Packaged Photo-Electric Burglar Alarm

IN the past, burglar alarms employing photo-electric cells have usually been custom-made products costing up to 100 dollars and more. A new burglar alarm, produced by Universal Control Devices, is a packaged unit stripped down to the simple essentials, so that anyone may understand and install it. Furthermore, it is quite inexpensive.

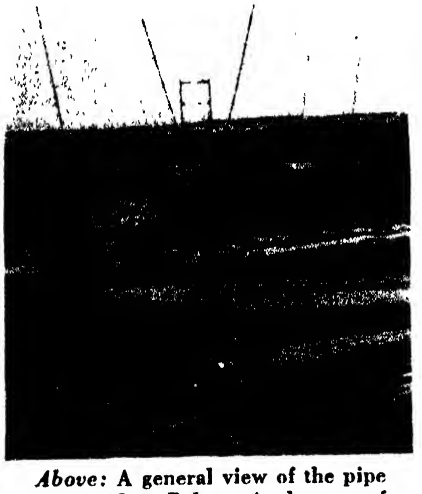
This new "electric eye" burglar alarm is a compact device consisting of two units—a light source which can be mounted anywhere and plugged into any convenient 110-volt alternating or direct current outlet, and a small boxed photo-electric cell which also plugs into a similar outlet. The units may be hidden from sight under a table-top, a desk, in a bookrack, or in any other convenient location, so that the beam crosses the door or window where the protection is needed. Any type of alarm (bell, gong, siren) may be used in connection with this equipment.

The manufacturer explains that with slight modification of the wiring of the amplifier, the unit can be used as a door-opening device, a switch for turning lights on or off, a counting device, a sorting device, or a detector of practically any kind of motion within the range of the light source.

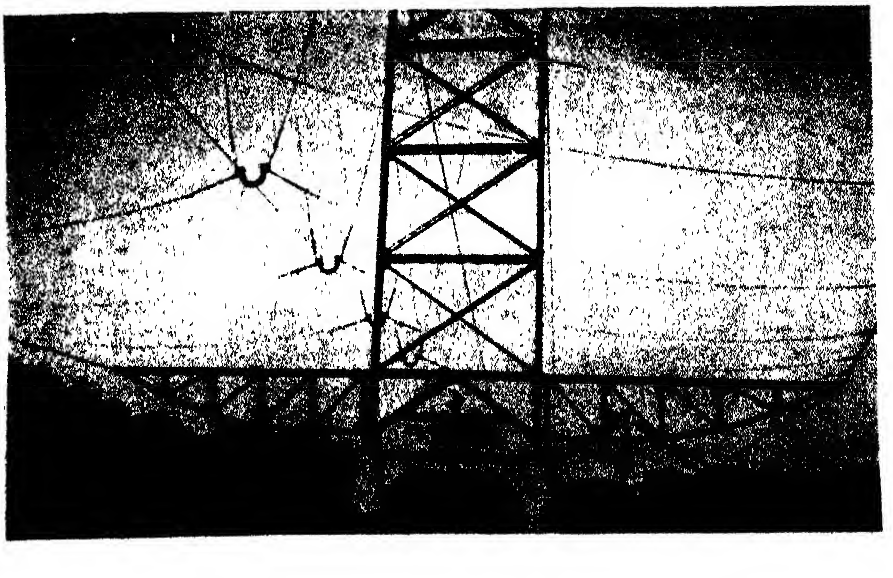
Pipe Line Bridge

IT is often necessary to suspend pipe between piers or towers to cross rivers. It is most unusual, however, for engineers to build a pipe bridge resembling a cross-country electrical power line. The two accompanying photographs show one such job which was recently completed, according to the Linde Air Products Company. It was constructed by the El Paso Natural Gas Company near Benson, Arizona, to carry natural gas.

The towers on this pipe suspension bridge are each 85 feet high and are 1000 feet apart. As will be noted in one of the photographs, two catenary cables swinging between towers support suspension cables, each pair of which terminates in a saddle to receive the 12¾ inch pipe. The pipe itself was welded in sections and fed out in different lengths from opposing towers. Cables pulled these lengths in, while men along the line steered the pipe in the saddles. After meeting in the center a tie-in weld completed the unusual engineering job.



Above: A general view of the pipe line bridge. Below: A close-up of one of the towers, showing structural steel work and guyed saddles



Indium

METALLIC indium, one of the rare elements, is added to silver used for plating to prevent tarnishing. The method used is to apply a plate of silver first and then a thin plate of indium over it, followed by a heat treatment which alloys the two metals.—*D. H. K.*

Aluminum Dust Effective Against Silicosis

DUST against dust, is the possible safeguard against silicosis suggested by researches of Dr. R. C. Sniffen, H. L. Collins, and Miss H. E. Williams of the Banting Institute, reports *Science Service.* The three researchers found that animals exposed to a silica dust similar to that found in many mines and quarries readily contracted silicosis, but that when aluminum powder was mingled with the flying dust the animals were protected.

Printer's Error Spotlights Macrozamia Trees

THE error of a printer out in Australia centered international interest on Macrozamia trees.

Professor Charles J. Chamberlain, of the botany department of the University of Chicago, had gone on a trip to make a world-wide study of Cycads, which include the Macrozamia. In the Tamborine Mountains of Queensland, Australia, he found an un-

usually large tree, 20 feet high, and spent some time studying this specimen known locally as the "Grandfather Peter" tree.

He told a local reporter that from his study of the leaf cycles he estimated the tree to be between 1000 and 1500 years old. A printer, inadvertently, added a zero to the number, making it 10,000. A contemporary paper boosted it to 15,000 and the American press copied the article under such headings as: "Our Sequoias are Mere Saplings."

California was especially interested as the age prestige of her *Sequoia Gigantea* was threatened.

When Merrill B. Pratt, State Forester of California, received a newspaper clipping to the effect that Australian Macrozamias were the oldest trees known, he came to the defense of the sequoias by writing directly to the Forestry Department of Queensland, Australia.

A letter from Dr. D. A. Herbert, in answer, explained the error and stated the age as estimated by Dr. Chamberlain. He also stated that this famous "Grandfather Peter" tree had recently been cut down by some thoughtless boys.

Thus the mantle of antiquity has been restored to the Sequoias.—*Cora L. Keagle.*

VIBRATIONS

A QUARTZ crystal oscillator developed for maintaining constant frequencies in radio transmitting, vibrates at the rate of 20 million vibrations per second, or just 16,666,666 times faster than the normal human heartbeat.

Film Titler

OWNERS of Filmo 8-mm cameras will find one of their most puzzling problems solved in the new titler just announced by the Bell & Howell Company. Designed especially for Filmo 8's, this new titler is a precision instrument consisting of a base and camera stand cast of aluminum in one piece, and an illumination arm which fastens securely to the camera support and bears two lamps. At the upper end of the camera stand is a special, highly-corrected copying lens in a snap-on-mount, to which the camera is fastened in the usual way after the regular photographic lens has been removed. The titler lens is accurately pre-focused on the title card holder on the base, directly beneath the camera.

The holder takes title cards of a convenient size; snapshots, magazine cut-outs, and other suitable backgrounds are readily available in this size.

Since the newer Filmo 8's are all equipped with a single exposure device, the titler is

Making a movie title

actually an efficient miniature animation stand. Animated maps, drawings, cartoons, and the like are all easily made. Since the titler lens has the remarkable depth of field of more than one inch, objects of considerable depth may be photographed in sharp focus. Insects, flowers, butterflies, will show up beautifully in color as well as in black-and-white; the titler permits interesting enlargement of all kinds of small objects.

Air Cleaner for Industrial Operations

A NEW machine, which conditions air by filtering out dirt particles and which is said to remove approximately 95 percent of the dirt from the air in the vicinity of grinding, welding, and other shop operations, is announced by The Lincoln Electric Company.

The machine also draws smoke and heat away from the work, thus contributing materially to the efficiency of welders and to the general improvement of shop conditions. It can also be adapted for blowing smoke away where such operation is desired.

The new air-conditioning machine, known as the "Linconditioner," has been developed to provide work-shops a more economical solution to the problem of cleaning shop air than that obtained with the conventional shop ventilating system. It removes the smoke and dirt at their source rather than after they have combined with large quantities of air. This requires less power, a motor of only one-half horsepower being required. Also, since no air is taken in or blown to the outside of the building, the new machine conserves plant heat.

The "Linconditioner" consists of a motor-driven fan which produces suction through a flexible metal tube. The fan draws the air through the flexible tube and exhausts it in a filter which is located in the periphery of the power unit.

When the "Linconditioner" is used for removing and filtering the air, a rubber cap is kept over the blower outlet. When used for blowing, the rubber cap is removed and the flexible tube is placed in the blower outlet.

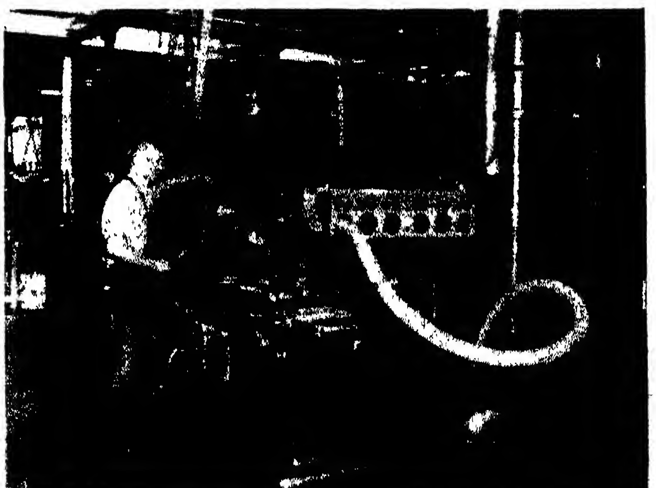
New Vitamins Not Always New

WHEN you hear that a new vitamin has been discovered, take the news with a grain of salt. Maybe the curative results reported were not due to a new vitamin but to larger quantities of an old familiar one. This has been the case in a number of instances, Prof. George R. Cowgill of Yale University School of Medicine has pointed out, according to *Science Service.*

Vitamin B, the anti-beriberi vitamin found in whole grains, is a case in point. For a time scientists kept discovering apparently new vitamins in the natural source until seven or more vitamins B were reported. At least three of these vitamins, B_3, B_4, and B_5, have turned out to be, in Dr. Cowgill's words, "a liberal supply of vitamin B_1."

Besides the vitamins there are other substances just as necessary for normal growth and development. These include the essen-

Air conditioning where it is most needed in a factory—at the source of air pollution. Carrying away welding fumes



Dust particles from a machining operation, as on a cylinder block, are removed with the new air conditioner

tial fatty acids and the amino acids. If these had not happened to be discovered first in already known food classes (fats and proteins), Dr. Cowgill suggested, they might also have been called vitamins.

Dr. Cowgill stressed the important difference for good health between a barely sufficient supply of vitamins and an optimal amount.

HOUSES

IT was recently estimated that at least eight million housing units will be needed in the United States during the next decade.

Glare Curbed in New Goggles

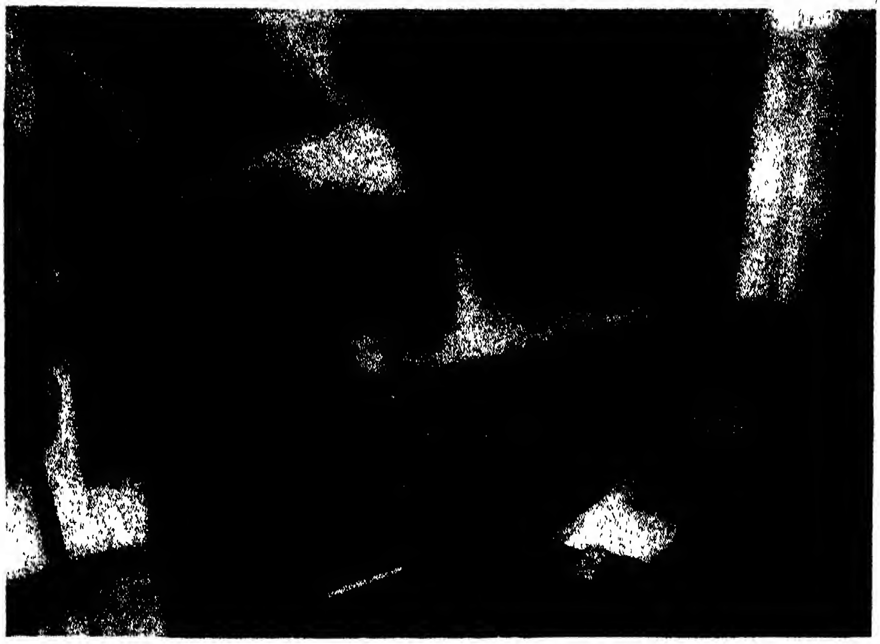
A NEW anti-glare lens, designed to absorb all radiant energy which does not contribute to vision and to transmit the radiations by which detail is seen, has been announced by the Bausch & Lomb Optical Company.

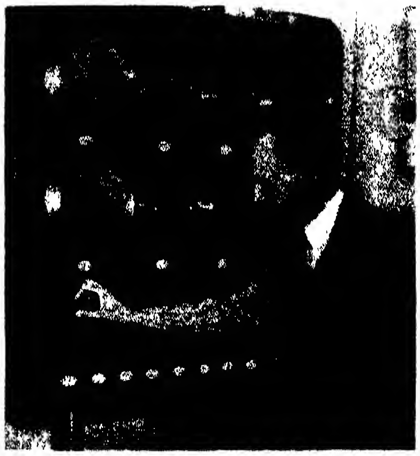
Developed primarily for fliers, to relieve eyestrain induced by the intense illumination in the upper atmosphere, the new lens is made of a dense new optical glass of a soothing green shade. Tests at Wright Field, Dayton, Ohio, indicate that the lens exceeds specifications laid down by government services for aviators' goggles.

The new lens is opaque to the harmful radiations of ultra-violet and infra-red, but completely transparent to the yellow and yellow-green radiations at the peak of the visibility curve of the eye. "The result is," says Scott Sterling, Bausch & Lomb technician, "that this lens achieves the utmost in visibility with the lowest transmission of useless energy radiations."

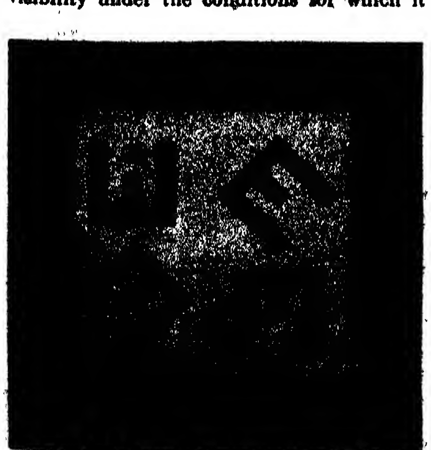
Sterling referred to a psycho-physical fact known as Purkinje's phenomenon as a probable explanation of the result achieved in the lens. "Under conditions of ample illumination," he explained, "the eye is most sensitive to yellow and yellow-green radiations; and under conditions of dim illumination it is most sensitive to green. A possible explanation is found in the theory that the cones of the retina, by which detail is perceived, are attuned to yellow radiations, whereas the rods of the retina which dominate vision in dim light are tuned to green radiations. We have succeeded," he said, "in developing a glass which transmits both the yellow and green, providing maximum visibility under the conditions for which it was designed and reducing undesirable radiations to the minimum. The lens does not alter the color of objects."

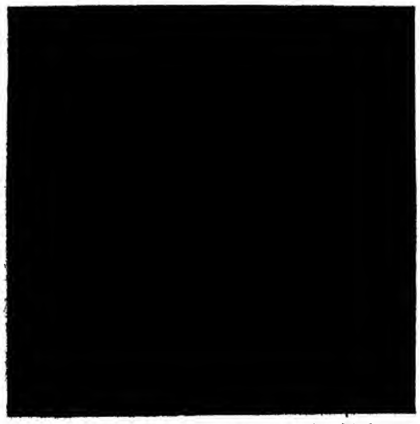
There are many colored lenses on the market, states Dr. E. H. Padden, flight surgeon of United Air Lines, but nearly all of them distort color to some extent.





Above: An ice-sheathed automobile under test in the new Ford "weather" tunnel where weather can be made to order. *Right:* Henry Ford at the control panel of the refrigerating system that reduces tunnel temperatures to 20 degrees below





Left: The sharp image cast by light which has been projected through a ground and polished goggle lens such as that described in the text. *Above:* Note the distortion and aberration of the same image when cast through an ordinary pressed goggle lens of poor optical quality

Ford's New "Weather" Tunnel

A HUGE new "weather" tunnel, the first of its kind ever built solely for scientific research in motor-car design, has been put in operation at the Ford Motor Company Engineering Laboratory in Dearborn, Michigan.

The new weather tunnel laboratory will be used, in conjunction with three new motor-car test tracks, to extend and broaden the intensive research carried on by the company's engineers, thus greatly simplifying the problem of perfecting motor cars of new design to meet all conditions, before they are put on the road.

The three tracks include a ribbon of concrete two and five-eighths miles long with banked turns for high-speed tests, and two other tracks, one of gravel, the other of various "rough road" surfaces. These provide a wide range of highways for "road" tests, complementing the laboratory tests in the tunnel. One million miles of such tests were driven in a recent seven months' period.

The tunnel is equipped to produce at any time inside a laboratory virtually every conceivable weather condition, enabling tests to be conducted regardless of actual road or weather conditions and without waiting for Nature to create the particular condition desired.

The purpose of the tunnel is two-fold. First, it makes possible reproduction in a laboratory of any kind of weather to be found anywhere on earth at any time of year. In the second place, it dispenses with the time factor.

Before the tunnel was available and when engineers had to rely exclusively on actual road tests, they were forced to send test cars all over the country and sometimes had to wait for long periods for appropriate weather before tests could be completed.

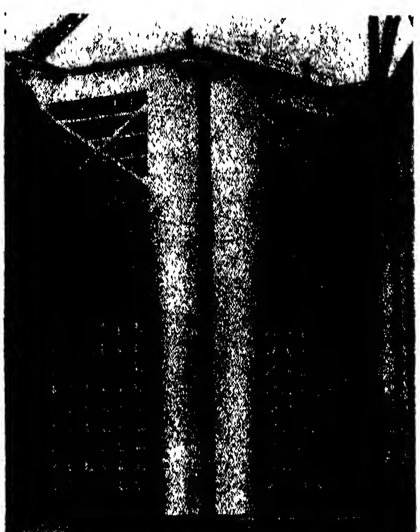
A 500-ton refrigerating system powerful enough to maintain a temperature of 20 degrees below zero in the tunnel, and other devices, including a rain machine and a sand and dust blower, now enable the engineers to duplicate at any time a wide variety of extreme conditions under which motor cars are forced to operate in actual use. In connection with the refrigerating system a "cold" chamber has been installed, in which temperatures as low as 40 below zero can be maintained. The room will be used for cold-weather tests of engine, oil, battery, and starter.

INGENUITY

A ROADSIDE fried-fish stand in New York uses six washing machines to exercise live trout in order to keep them from getting flabby. A Connecticut goat farmer uses vacuum cleaners regularly on his horned and bearded flock. A potato-chip manufacturer in Texas has used for years a spinner washing machine to "wring" the water out of fresh potato slices.

Tallest Lock Gates

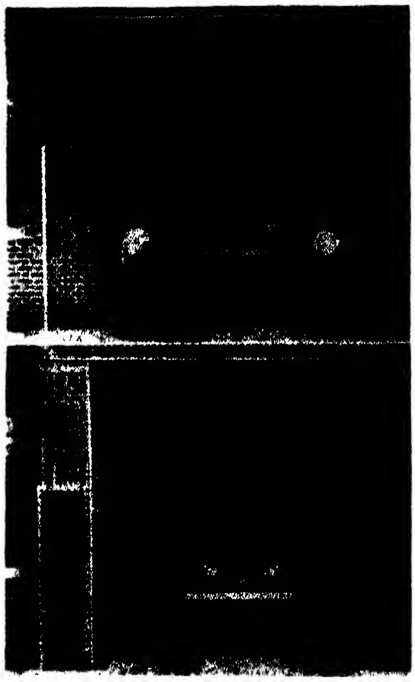
THE lower pair of lock gates that will close against the waters of the Columbia when a ship wants to pass Bonneville Dam, tower up like diminutive Flat Iron Buildings. Made of riveted plates supported by a steel framework, each leaf or gate represents 600 tons of fabricated steel work, and stands



A vivid impression of size is given by the men atop these lock gates

100 feet high. Yet they are fabricated and hung so accurately that, when closed, they form a metal-to-metal union that is perfectly water tight.

They are the tallest lock gates ever constructed, surpassing by 18 feet the 82-feet-high gates that serve the Miraflores locks of the Panama Canal. McClintic Marshall, now the Construction Division of the Bethlehem Steel Company, which constructed the gates for the Panama Canal, is likewise fabricating and erecting the Bonneville Gates. Gates of the same design, 46 feet high, are employed at the upper end of the lock. The lock is 76 feet wide and each leaf of both the upper and lower gates is about 44 feet wide.



Grille-gate, closed and open

The gates were fabricated in sections at Bethlehem's Pottstown Works. After each section was planed to precision measurements, the gates were given a trial assembly as a check for accuracy, then separated again into sections for shipment to the dam site. Silicon steel was employed for main sections in both upper and lower gates, and carbon steel was employed in the remainder of the construction.

Photographic Records for Business Houses

FOR years, business offices, industrial firms, libraries, historical associations, museums, and similar institutions have been troubled with the problem of how to preserve in economical, space-saving form their records, correspondence, valuable papers, manuscripts, books, and the like. Microphotography has found the answer by making it possible to record such material on film. And a new invention called the Photorecord, manufactured by Folmer Graflex Corporation, places this service within the reach of anyone desiring it.

The Photorecord, by permitting as many as 800 newspaper pages or 1600 smaller pages to be recorded on one roll of 35-mm film four inches in diameter and two inches thick, permits a reduction in storage space of as much as 95 percent. In fact, the contents of 32 filing cabinet drawers may be filed in one drawer in film form. The acetate film used will last as long as record paper of the highest quality.

Duplication is also made easy with the Photorecord. Thus, organizations and institutions may keep a permanent file of original material and make copies for use in branch offices or other distant points.

In spite of this great versatility and usefulness, probably the greatest advantage of the Photorecord is its economy. It is a compact, completely portable camera apparatus weighing only 42 pounds when packed. In it is combined everything necessary to photograph anything occupying a relatively flat plane up to and including a full newspaper page, and to record it in miniature form on a strip of film that takes up but a tiny fraction of the space occupied by the original. It will produce 800 double-frame pictures and 1600 single-frame pictures on a single loading of 100 feet of 35-mm film.

A convenient foot pedal operates the equipment and leaves the hands free to handle the subject being photographed. Each time the pedal is pressed down, the film is positioned, the lights are turned on from half to full Photo-flood intensity, and the shutter is actuated. So simple is its operation that speeds of from 500 to 1000 exposures per hour may be made.

Telescoping Grille-Gate

AN ingenious new grille for a gate or doorway which provides perfect closure against intruders and yet permits free circulation of air, has been developed by Cornell Iron Works, Inc. This grille is a flexible steel curtain hung from an overhead track, as illustrated in the two accompanying pictures. Made of heavy galvanized chain link mesh, it is extended to any height of opening by galvanized vertical rods running to the supporting track above.

Because of its clever construction, this new sliding grille telescopes together and will nest at the side of an opening in very small space. It will also travel around a sharp curve and lie at a right angle to the opening. For more complete control a bottom track can also be furnished. The entire structure can be made in aluminum throughout or of stainless steel.

Resinous Coatings for Paper

A NEW method has recently been developed for applying coatings of resinous mixtures directly to paper without the use of a solvent. A mixture of resins, waxes, and other materials melting at a low temperature is spread on the paper in the roll as a continuous operation. The temperature and thickness of the coating are controlled.

Photorecording the pages of a book

The process is said to be cheaper than lacquering since it avoids the use of solvents and its cost is little higher than that of wax coatings. By selection of the ingredients of the resin mixture a variety of results can be easily obtained to meet any ordinary requirements. The weight of the coating can be varied at will by proper adjustment of the machine for applying it.—*D. H. K.*

HARNESS!

GAS and oil are closer than hot dogs and mustard! To harness the power of every 50 gallons of gasoline in the automobile tank, one gallon of oil goes into the crankcase. A gallon of transmission and differential oils is needed for every 282 gallons of gasoline. For every hundred gallons of gasoline, a little more than a pound of grease is used.

"Doctor Jones" Says—

"UP in the city, here a while back, the chief of police (he was raised down here in our place), they'd been having an examination to fill some places on the force and one of the most promising applicants—his Wassermann test was positive. The question came up right away whether they ought to turn him down or put him on. He admitted he'd had syphilis, this fellow did, but he'd been taking treatments for something like six months. That same question—I suppose it comes up a lot of times when folks are looking for jobs. He asked me—the chief did—what I thought about it. When I said 'I'd put him on,' it seemed to sort of surprise him.

"Well, when you stop to think of it, why shouldn't they? Here was a husky young fellow—he'd been under treatment right from the start, before any permanent damage had been done. His condition wasn't infectious and it wasn't going to be, providing he kept up his treatment 'til he was cured—and, of course, they were in a position to see that he did. There was no reason why he wouldn't make a perfectly good cop and last just as long as any of 'em.

"Then you take folks working in restaurants and such places—food handlers. In some towns they have regulations that they've got to have Wassermann tests. Of course it's a good thing for *anybody* to have the test, for that matter, but the main trouble with such a regulation is—when they get a positive reaction they seem to think, a lot of 'em, they ought to take 'em away from their job. Well—there's just about as much danger of getting syphilis through food as there is fracturing your skull falling over a splinter from somebody's wooden leg—if you can figure that out. I said something like that to one man a while ago and he said, 'All right—would you like to think your food was being handled by somebody that had syphilis?' Well, for that matter I wouldn't like to think of its being handled by a lot of 'em that haven't got syphilis, either. The ones to worry about are the ones where there's some real danger—like typhoid carriers, and so on.

"No. There's people working all around us that have syphilis and sometimes even they

themselves don't know they've got it. Everybody ought to have a Wassermann test for his own protection—and his children's—but we can't expect 'em to warm up to the idea if they're liable to lose their job as a result of it. What we want to do is get 'em under treatment—those that need it—before serious damage has been done. The syphilis cases that are infectious, if they spread the disease it's pretty safe to say it won't be by working at their jobs."—*Health News*, New York State Department of Health.

Sulfur from Gypsum

SCARCITY of sulfur in India has fostered the development of a process for recovering sulfur trioxide from gypsum and bauxite. These two minerals are mixed in the proportions of two of bauxite to five of gypsum and heated for six to seven hours between 1200 and 1250 degrees, Centigrade. The sulfur trioxide produced can be used in many ways. As a by-product of the reaction, calcium aluminate is produced from which alumina can be recovered by treatment with water.—*D. H. K.*

The 20 Percent Industry

TRANSPORTATION contributes more dollars to national income than agriculture does. For each seven dollars that agriculture adds to our total income, transportation contributes eight dollars. If you think that agricultural prosperity is important for our national well-being, you ought to think that the prosperity of transportation is equally important. Railroad transportation is by far the largest element in total transportation.

Railroading is our 20 percent industry. At present prices, the values of railroad securities are equal to 20 percent of the total values of all our listed corporation stocks and bonds. The railroads purchase 20 percent of our bituminous coal and 20 percent of our fuel oil. They buy 20 percent of our total output of lumber and 20 percent of our iron and steel. Railroad prosperity is an essential component of national prosperity. —*Colonel Leonard P. Ayres*, in *Railroad Data*.

Science Still Baffled

SCIENTISTS are still searching for a hidden clue or perhaps a new and unknown principle of physics which can explain the large magnetism of the earth and the far vaster magnetism of the sun, says Dr. M. A. Tuve of the Department of Terrestrial Magnetism of Carnegie Institution of Washington.

For 10 years, the Department, under the leadership of Dr. J. A. Fleming, has searched for the answer to the baffling question, the solution of which would make clearer the rôle played by the earth's magnetic field in man's daily life—a rôle which affects radio, wire communication, cosmic ray intensity, the amount of ultra-violet light striking the earth, and many other factors in man's existence.

The program which began and still seeks explanations of earth and solar magnetism has led into the hearts of the tiniest things in the universe. But neither the tremendous force there discovered nor any other fact of

modern physics has yet led to a clue which might explain the permanent magnetism of the earth. To explain these large magnetic fields in the sun and earth, it appears that either some new complexity will have to be introduced into the fundamental concepts of physics or that some new and yet unfound principle of physics will have to be discovered.—*Science Service.*

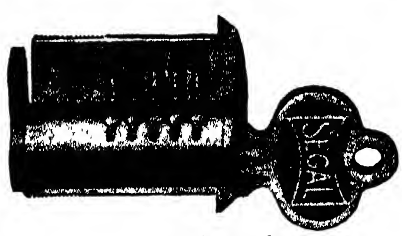
ELECTROLYTIC FLAVORING OF SHERRY

PART of the flavor of fine old sherry wines has been found to be caused by the presence in them of acetaldehyde. This is produced in the wine by oxidation; a recent investigation has shown that electrolysis is the most satisfactory method of accomplishing this. By combining electrolysis with a heating process, a more satisfactory flavor can be produced in California sherry wines.—*D. H. K.*

PICK-PROOF LOCK CYLINDER

A FORMER detective on the New York Police force, Samuel Segal, inventor of the Segal Jimmyproof Lock, has just perfected a non-pickable lock cylinder which is so constructed as to prevent its opening by the use of any instrument other than the owner's key.

This device successfully solves the problem which has baffled foremost engineers of the hardware industry since the invention of the pin-tumbler type of lock. It may



Pick-proof

not be generally known except to the initiated, who make it their business to track down crime, that a very large majority of mysterious burglaries are committed through the use of lock-picking instruments inserted in the keyway of a lock with uniformly successful results.

The Segal Pick-Proof Cylinder, the first answer to the lock-picking menace, retains the essential features of the pin-tumbler mechanism but, with important improvements, is rendered impregnable. A lock-pick, usually in the form of a thin piece of steel or wire inserted in the ordinary cylinder while tension is exerted on the cylinder plug, can manipulate the pin tumblers to an evenly aligned position above the plug and up into the cylinder shell so that the lock can be opened.

The Segal Pick-Proof cylinder contains an oscillating protective sleeve fitted over the cylinder plug. The pin drivers are headed and undercut. When a lock pick is inserted in this cylinder, the pins uncontrollably trap and are locked by recesses in the protective sleeve. The failure of even one pin to rise above the plug can prevent a cylinder from turning open. In the Segal Pick-Proof Cylinder, ten built-in locking devices prevent the control of all interlocking pins.

The cross section photograph of the pick-proof cylinder shows the series of locking points, the undercut drivers, and the inter-locking protective sleeve which afford complete protection against all methods of lock picking.

The new pick-proof invention can easily be installed on any lock by merely replacing the present cylinder.

Deodorizing Paper Mills

Manufacture of kraft paper by the sulfate process produces disagreeable odors which threaten to become a nuisance to the neighbors of such plants. Recent investigations have shown that treatment of the fumes from pulp digestors with chlorine will destroy this odor. The amount of chlorine required is about 25 pounds per ton of pulp produced but its application is expensive. No valuable by-products have been found as yet to cover the cost of the operation.—*D. H. K.*

Mr. Skunk Teaches the Railroaders

The cute little fur-bearing animal with the smelly way of warding off personal danger, which has long made him a social outcast, now has reason to be proud and happy. For at last he has taught man a useful lesson, one that is proving especially helpful in railroading.

Witness a recent bulletin directed to Southern Pacific trainmen and enginemen by W. L. Hack, superintendent of the company's Sacramento division:

"Roller bearing boxes on the streamliner *City of San Francisco* are equipped with odor bombs which discharge an obnoxious odor in the event the journal bearings run excessively hot. When you detect such odor, train should be stopped and an inspection made."

Passengers, of course, will never be aware of the latest means of preventing operating delays, for they ride in air-conditioned cars with sealed windows and tight-fitting doors. So they can give whole-hearted thanks.

Draw-Casting New Trick in Making Copper Rods

One of the older arts of metallurgy is the fabrication of castings by pouring molten metal in a mold and allowing the whole mass to cool. Then the mold is broken away and one has the casting. The method, of course, is a great advantage over the alternate task of trying to fashion the crude block of cold metal in the desired form.

The art of making castings, then, is old but there is a new technique which is only now coming into production. It is called draw-casting. It consists of drawing, directly from a bath of molten metal, rods and tubes of copper.

Dr. Byron E. Eldred, new president of the Engineers Club, New York City, and one of the nation's few remaining independent research scientists, is the inventor of draw-casting.

Dr. Eldred melts his copper in a furnace which has one or more holes in the bottom.

In each of these holes is inserted a copper rod that is going to be the "parent" of hundreds of feet of additional rod the same size. These parent rods are cooled by a surrounding water chamber and transmit their coolness up into the molten copper. Around each of their tips the melted metal starts to "freeze" and in turn becomes cooler. As the metal in the bath freezes, from the inside out as it were, the rods are pulled out and continually solidify more metal within the furnace.

The process, in one sense, reminds one of the old-fashioned method of making candles by dipping. At each dip the cool candle froze more crystals of wax and the candle continually grew larger and fatter. Since Dr. Eldred is not seeking "fat" copper rods he continuously pulls out the newly frozen copper at the end of the rods and gets continuous production that is a time- and effort-saver over present casting and rolling and drawing methods.—*Copyright, 1938, by Science Service.*

Caliper Map Magnifier

The utility of road maps is so well known that an attempt to ameliorate their worst fault—illegibility—has been made by the Bausch & Lomb Optical Co. It has introduced a new magnifier of high quality,

To measure or magnify

mounted in zylonite, with a pair of hinged calipers for the estimation of distance between towns. The little instrument is about two inches in diameter and comes in a neat, full leather, pocket case.

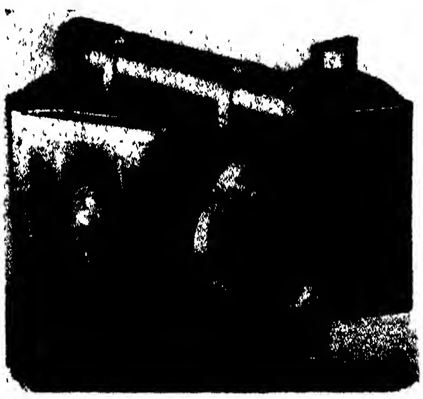
Coloring Copper

Copper can be given various colors for decorative purposes. A simple treatment consists of cleaning the metal thoroughly in dilute sulfuric acid (1 to 15) and immersing the clean metal in a solution of one ounce of potassium sulfide per gallon of water at room temperature. This produces colors from golden brown to almost black, depending upon the length of time the copper is left in the solution. Reddish purple can be produced by immersing clean copper in a freshly prepared warm solution of 1 ounce of ordinary hypo (sodium thiosulfate) and half a dram of nitric acid in 20 ounces of water. This solution should be warmed to 120 degrees, Fahrenheit, and the copper need be immersed in it for only 30 to 60 seconds.—*D. H. K.*

Conducted by JACOB DESCHIN

Color for All

THERE are so many people at work attempting to bring good color photography to the masses that it is inevitable we shall one day see color methods so perfected that even the amateur, following printed instructions, will be able to turn out creditable work. Today we already have such color media as Kodachrome and Dufaycolor, but the amateur, and even many professionals, must turn to the manufacturer to do the processing so that the best possible results may be achieved. In the case of Kodachrome, there is no choice as the processing is a highly complicated procedure and Rochester insists on doing the processing in order to insure getting the best results.



The new "one-shot" color camera designed for amateur photographers

So the amateur taking color pictures has only two things to think about: 1, to give the correct exposure; 2, to illuminate the subject properly. That sounds simple enough and yet it is surprising how many, professionals included, will sin on both counts. In "black and white" photography it has been a matter of long experience that the film has such wide latitude that one may make any one of quite a number of different exposures and get a printable picture from each of the resulting negatives. In color photography, however, it is important that the absolutely correct or very nearly the absolutely correct exposure be given in order to achieve good results. This is generally known but often overlooked. Ascertainment of the correct Scheiner, Weston, or other speed rating for the film used, use of the proper filter where called for, and selection of the correct shutter speed for the diaphragm opening employed, based on the manufacturer's rating and determined through the use of a good photo-electric exposure meter—these will win half the color battle.

The other half lies in proper lighting. This means simply that illumination should reach all parts of the subject more or less in the same intensity. Deep shadows are taboo, however much they may add to the effectiveness of a picture in black and white. Flat, all-over lighting is the general rule, because in color photography the contrasts that must, in black and white, be obtained by varying shades of gray, are already provided in the varying hues embodied in the subject. In the one, different tones of the same color are manipulated, whereas in the other, different hues or colors provide the contrasts.

That seems plain enough and obvious enough and yet it is a truth honored more often in the breach than it should be, even among professionals, as those who visited the recent First International Show of Color Photography in New York City can testify. At this show, the attendance at which indicates the high interest in color photography prevailing today, it was made at once apparent that the man behind the camera is still the deciding factor in the production of beautiful pictures. The materials are here, the equipment is here, but not all are Nickolas Murays or Paul Outerbridges. The same applies in black and white photography, of course, but in color those who excel are still a very, very small minority.

At this show the new Devin color camera was introduced that is destined, according to its distributors, to make good color photographers of us all. The price is some-

Prize Winners in Our

1ST Youthful happiness in one of its many forms was captured photographically by the Rolleiflex of R. B. Stewart, Yellow Springs, Ohio. Exposure was made on Agfa Superpan

what on a par with the highest priced miniature cameras. The camera, which is a one-exposure tricolor outfit, making three exposures at the same time, one for each of the three primary colors, red, green, and blue, makes three 6.5 by 9 cm (2½ by 3½ inches) color-separation negatives from which color prints are later produced. The "miniature" color camera is modeled on a larger professional outfit now being used by such men as Nickolas Muray, Anton Bruehl, and others.

The new camera is equipped with a highly color-corrected F:4.5 anastigmat lens and affords, besides the usual ground-glass focusing, a coupled range finder and direct view-finder.

The possibility of exposing three negatives at the same moment is brought about through the use of so-called pellicle semi-transparent mirrors, two of which are employed in the Devin camera. The procedure is explained by the distributors as follows:

"The image is formed by a single lens as in the case of any ordinary camera. The image reaches a first semi-transparent mirror, which reflects part to a plate at one side of the camera and transmits the balance. This reaches a second mirror of the same type and part is reflected to a plate at the other side of the camera, the balance being transmitted to a plate at the rear.

"The standard red, green, and blue filters are placed in front of the three plates. The result is three negatives identical in every respect except the way in which the various colors have been recorded. These 'color separation' negatives are then used for the production of a paper color print."

Contrast Theme

OBVIOUSLY what attracted the photographer to the scene pictured in "Beauty is Where you Find it" was the juxtaposition of the "Celia Beauty Shop" and the back view of the line of tenement houses, with their wash hanging out to dry and household paraphernalia on the fire escapes. The contrast between the two ele-

"Happiness" Competition

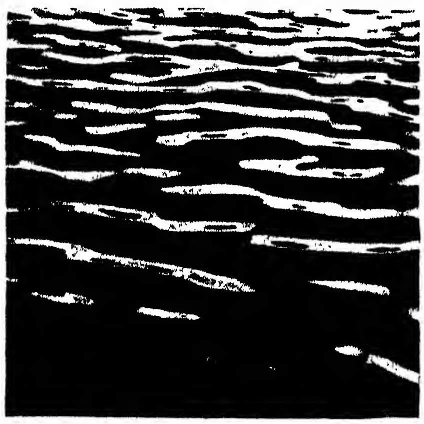
2ND Domestic happiness—simple, deep, sincere—as interpreted by the Graflex of Stephen F. Harris, Dover, Massachusetts. This picture was taken on Eastman S. S. Pan film

"Beauty is Where You Find It"

ments of the picture is emphasized and made unmistakable by the quiet highlighting of the little beauty-shop house. Without this highlighting the picture would not have quite the appeal it now possesses. Incidentally, the strolling figure in the foreground, though practically a silhouette, certainly helps to make the picture complete. The shot was made from the seventh floor of an apartment house on the opposite side of the street.

"To Sea or Not to Sea"

TO add a light note to our department this month, we offer our patient (we hope) readers this example of what happens when the photographer runs into a bit



"To Sea or Not to Sea"

of luck. You will observe that the snipped ribbons of light are broken up in places by elongated black areas, giving the illusion of weird floating masks. We caught the bird on the brink of the water looking dubious, we presumed, about flying over that grotesque area. And so, "To Sea or Not to Sea." Get it?

Mounting Kink

IN mounting large prints on 16 by 20-inch cardboard mounts you may have observed that unless you placed the mounted picture in a glass frame the mount eventually bent inward somewhat. This is due to the pull of the print. A way to overcome this is to paste on the back of the

mount a sheet of heavy brown paper about the same weight and size as that of the mounted print itself, or, better still, a discarded print of the same weight and size. With the print on one side and the paper on the other each pulling on its own account, a balance is met and the mount remains flat.

Misty Days

DON'T neglect your picture-making on days when there is no sun or because there is a heavy mist all about. There is some attraction in pictures made on such days that is not to be equalled on sunny days. Misty days are peculiarly days of mood, when scenes ordinarily without interest because so thoroughly familiar or for some other reasons, acquire a strange mystery that lends a newness and charm the camera user would do well to attempt recording photographically. The sharp lines and clear distinction of subject-matter that is revealed by normal lighting are softened and shrouded so that only their outlines are seen.

Scenes on the water on such days provide some of the best material for the photographer in search of the pictorial elements of our daily existence. Go to the waterfront, take a ferryboat, or mount some high elevation so that you may hunt your subjects without the interference of nearby material. Obviously, you will not wish to use mist-penetrating filters because the mist is what you want to get. Your negative will look flat but that is as it should be and your print may look fogged, and that too is all right. You will generally get no blacks and the picture will seem to lack contrast. Actually, however, nothing that is visible, either to the eye or the lens, is really lacking in contrast because if it were you would not be able to see it. It is merely that this contrast in misty pictures is weak or low.

"The Ferryboat Leaves"

"Mist on the North River"

Both pictures illustrating this discussion were taken from the vantage point of a ferryboat. It is interesting to note that while "Mist on the North River" shows a gradual recession of tones from the boat in the fore-

ground to the skyscraper in the distance, revealing at least four different tones (despite the "lack of contrast"), "The Ferryboat Leaves" shows contrast much more abruptly. This is due, of course, to the fact that although mist pervades the atmosphere, objects closer to our vision are seen more clearly than objects in the distance. In "The Ferryboat Leaves" the ferryboat in the foreground shows good black tones although the skyline in the distance is barely perceptible through the mist. Also, it must be noted that a large expanse of uninteresting water was eliminated in "Mist on the North River," thus taking in more of the distance, while in the other picture, the foreground was retained entirely and the distant scene cut down considerably.

WHAT'S NEW
In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

PANTHERMIC 777

THE long-talked-about Harold Hervey developer, Panthermic 777, is finally available to the public. Panthermic 777 ($3.00 for the unit to make two quarts—one quart of basic developer and one quart of replenisher) is distinguished by the fact that the temperature of the developer may run anywhere from 70 to 90 degrees. The developer, therefore, never requires chilling, being used at whatever the temperature in the room happens to be at the time development is started. The recommended temperatures are from 80 to 84 degrees, with the standard at 80 degrees. Times of development vary with the temperature, the higher the temperature the shorter the developing time.

VUESCOPE

EQUIPPED with a high-power magnifier said to produce a stereoscopic effect, the Vuescope ($12.50) for viewing 35-mm black and white positives or color transparencies, as well as two by two-inch slides, is equipped with an adjustable lighting system. An adjustable stand is available for setting the device at the proper height and angle for comfort in use. (Vuescope with stand $15.00.)

FILM WINDER AND MEASURER

WINDING 35-mm film from bulk rolls is simplified by the Robot Film Winder and Measurer ($23.00). The device is set in advance in ordinary light, but winding is done in the dark. In use, the photographer sets a dial in the face of the instrument to the length of film to be used. The bulk film is then fed over a protecting guide, under the measuring sprocket, and to the camera spool. The operator then simply turns the take-up knob till it will go no farther. A built-in knife cuts the film at this point, the bulk film is removed and the wound roll en-

closed in its cassette. A chart enclosed with the winder gives the number of exposures at various lengths for every type of 35-mm camera.

Spun-Glass Diffuser

Designed for use with the Eastman Kodaflector reflector, the Kodaflector Diffuser ($1.25 each; $2.25 pair) is now on the market. The diffuser, a disk of white spun-glass fabric 13 inches in diameter, is mounted in a metal rim. A bracket and U-shaped rod are supplied for attaching to the socket of the Kodaflector.

Elkay Adjustable Rapid-Drain Tank

Accommodating cut film, film pack, or plates and instantly adjustable to take any of four negative sizes, 6 by 9 cm, 3¼ by 4¼ inches, 9 by 12 cm, and 4 by 5 inches, the Elkay Adjustable Rapid-Drain Tank ($6.50) is designed to develop, fix and wash negatives in the same tank. All operations, after the loading of the film and adjusting the tank cover, may be carried through by ordinary artificial light or full daylight. The tank is resistant to acids and bases of photographic solutions; the negative holding slots or grooves are made of stainless steel and so designed that no damage is possible to the film or plate.

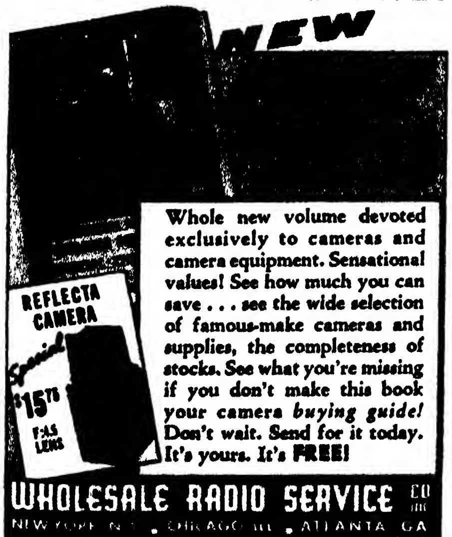
Following the loading and covering of the tank, the developer is poured in through the top, special channels carrying the liquid down the inside edges of the tank. A plug in the bottom of one side empties the tank rapidly and completely. The inside bottom is gently sloped so that all the liquid drains without tilting or turning the tank. Stop bath and hypo are introduced in the same way. The washing is done with the cover removed.

Adjustable Reflector

Designed particularly for the different sizes of flash bulbs now on the market, the Mendelsohn adjustable reflector has been introduced as an accessory reflector for the Mendelsohn Speedgun flash synchronizing equipment. The holder for this reflector is inserted in the same slot which ordinarily carries the leg of the fixed-focus reflector. The reflector slides up or down on this support and is locked in position by a set screw. The new reflector is used in centering the bulb in the reflector in order to gain maximum lighting efficiency.

Ihagee Projection Lantern

Designed to accommodate either two-inch square glass slides or film strips in single frame (¾ by 1 inch) or double frame (35-mm miniature negatives), the Ihagee Projection Lantern ($67.50) is now made available for projecting on a screen



both color films and black and white positives. The large light output demanded in the projection of color films is facilitated in this projector by a special large-aperture projection lens and a triple condenser with heat screen. In addition, the design includes a special concave mirror, rotating device for upright or longitudinal pictures, and a special arrangement for moving the film strips continuously or picture by picture, as desired.

THREE CONTAX ITEMS

THERE is now available a 15th Contax lens—the Orthometar F:4.5, 35-mm focal length, wide-angle lens covering 62.5 degrees. ($90.00.) Built according to the formula of the Zeiss Orthometar for photogrammetrical use (aerial survey photography for map-making), the Contax Orthometar gives full correction over the entire negative area.

The Contax may be used as a reflex camera by the employment of the recently introduced Flektoscope. Designed for use by owners of long focus lenses and affording a magnified image, the Flektoscope is made in three models with long focus lenses, the Sonnar F:2.8, 18 cm, the Tele-Tessar F:8, 30 cm, and the Tele-Objective F:8, 50 cm.

The third accessory is the Contax Harness ($20.00) which is supported from the neck, enabling the Contax user to have his camera in position at all times, leaving the arms free. The device consists of a leather strap around the neck, a brace across the middle of the body, and metal arms from the brace to the swivel to which the camera is attached at eye level.

AUTO-FOCUSING PRECIS 66A

COMPLETELY automatic focusing is the principal feature of the Precis 66A enlarger ($85.00), just announced. Interchangeable for either condenser or diffuser illumination, the Precis has an auxiliary manual control for adjusting the focus to the individual lens, although the focusing cam is synchronized only to the regularly provided 9-cm lens. With other lenses the focusing is manual. The enlarger outfit includes the Laack F:4.5 anastigmat 9-cm lens mounted in a standardized board; negative holder to take any size negative up to 6 by 6 cm. (2¼ by 2¼ inches); linear magnification up to 7½ times and with supplementary lens up to 12 by 16 inches enlargements; double condensers and opal glass; oversize lamp-housing accommodating 75 or 100 watt lamps, with lamp position adjustable; baseboard 18 by 19 inches of specially seasoned plywood, polished, balanced by rubber legs; red filter; and other details.

HOLLYWOOD ENLARGER-PROJECTOR

DESIGNED for use either as an enlarger, projection camera, or copying stand, the Hollywood Enlarger-Projector, equipped with a two-inch F:4.5 anastigmat lens with iris diaphragm ($35.00) or with a two-inch

F:3.5 lens ($40.00), encompasses a number of attractive features.

The Hollywood takes 35-mm and half vest pocket negatives. While the enlarger-projector may be purchased with either an F:4.5 or F:3.5 anastigmat lens, the apparatus may also be supplied with an adapter permitting the use of Leica, Contax, or other miniature camera lenses. The negative holder eliminates the use of glass pressure plates; the condensers are two 2⅛-inch improved French ground and polished crown optical glass condensers; the baseboard is of five-ply Philippine mahogany and measures 15 by 20 inches; the revolving head permits vertical or horizontal projection; the extension arm, which slides back and forth, permits the making of larger prints right on the baseboard and allows the head to be tilted sideways for elongation or caricature effects or for use in copying or photomicrography; the 15-foot cord is of No. 18 black rubber covered tandem wire with a toggle switch and rubber connecting plug.

Eight-oz. Nikor Tank

A NEW model of the Nikor stainless steel daylight developing tank is now on the market. Designed to develop, fix, and wash full-length 35-mm rolls of 36 or 40 exposures in only 8 ounces of water, the tank is known as the Model 35 ($5.75) and employs the new, smaller type reel, the same size as the ones used in the Model 33 which develops either one reel in 8 ounces of solution or two 35-mm rolls simultaneously in 16 ounces.

Leitz Continuous Projector

PERMITTING up to 12 slides to be shown repeatedly, in consecutive order, for intervals ranging from 10 seconds to a minute for each slide, the Leitz Automatic Continuous Projector ($90.00) is designed principally for use in educational displays, museums, public buildings, or expositions, and, in some cases, even for lectures.

The projector, for use either in standard front-projection or rear-projection on a translucent screen, takes the regular two by two-inch square glass slides, either in black and white or color transparencies. The essential feature of the automatic projector is a revolving circular disk with twelve two by two-inch slots, equally spaced around its outer edge, which serve to hold the slides to be projected. An AC-DC motor mounted on the baseboard of the continuous projector causes the disk to turn at pre-set intervals.

Keep It Clean

A CAMEL-HAIR brush is a handy thing with which to keep camera lenses and shutters clean, as well as for dusting off negatives and enlarger parts in the dark room. Made especially for these purposes, the Dustoff Photo Brush ($1.00) consists of soft bristles embedded in a dust-proof case which is provided with a cap to protect the brush. Opened for use, it is only 2½ inches long.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. I should like to standardize on either S.S. Pan or Agfa Superpan film, so that I can take pictures by daylight and artificial light on the same film. The question is: what filter should I use to make S.S. Pan give me the same results in daylight as Verichrome film will? —J. B. T.

A. Many workers use panchromatic film for all their subjects because of its full color sensitivity as well as because of its greater speed. These are probably the reasons for your decision to use panchromatic film exclusively. While generally satisfactory when used without a filter in daylight, a green filter is often employed when it is desired to bring the panchromatic film more in line with the contrast afforded by such a film as Verichrome, panchromatic film being characterized by a low sensitivity to green. Similarly, when working by artificial light, because of the panchromatic film's great sensitivity to red, a blue filter is found helpful.

Q. I would appreciate it if you would tell me the name of the company which handles camera insurance. I read your article in the November issue and I would like very much to obtain some insurance for my camera.—Miss H. M.

A. Due to the growing interest in camera insurance, many companies now write this type of protection, including most of the fire and casualty companies. Therefore, if you will consult the company which now covers your regular household belongings, you will probably have to go no further. We would be glad to include the names of such companies, but the list would be too long and may easily be consulted in the Insurance Brokers Placing Guide (published by the Insurance Advocate), which gives a complete list of the companies writing camera insurance.

Q. Could you recommend a camera to me? I don't want one that is too costly and I am not a candid camera fiend. I travel around the country a lot and frequently see things that I would like to photograph, so I want a camera that is small and uses a small film; one that does not require intricate adjustments to take a good picture under average conditions. I would like to be able to sit in the car and snap the camera and feel that I would get a good picture.—L. W. S.

A. Of course, you understand that we are not in a position to recommend any specific cameras, but we can say that inexpensive, small cameras of the general-use type you are after have lately been introduced in great numbers on the American market. The prices start at about a dollar and many varieties are available for the man who wants to keep his expenditure under $25 or $30. A visit to one or two of the large photographic supply houses and inspection of the various low priced camera wares should give you some idea of the type of camera best suited to your purposes. Most of these inexpensive cameras are very simple to operate and require only a few minutes' instruction to acquaint you with their mechanical operation. As for snapping pictures while sitting in the car, we should say off-hand that relatively few pictures, no matter what the camera used, are possible from such a restricted vantage point.

Q. What is the fastest shutter speed available on modern cameras?—A. N. P.

A. One popular 35-mm camera has a top shutter speed of 1/1250th of a second, while one of the larger models has a top speed of 1/2000th of a second.

Q. I have read that the short focus lens is not adapted to the taking of distant landscapes. I should not want to sacrifice entirely the distant scene even for the compactness and convenience of such (6 by 6 cm reflex) cameras. Can you advise me on the capacity in this direction of short and longer focus lenses?—B. N. W.

A. The distant scene is not *entirely* sacrificed with the short focus lens. Naturally, you cannot expect to get the same results in this direction with a short focus (miniature camera) lens that you can with a lens of longer focal length on a larger camera. It is not so much a matter of focal length, however, as it is the degree of enlargement to which the negative is to be subjected. Miniature negatives are practically always enlarged, whereas larger negatives often are satisfactorily printed by contact. It has been

our experience that when using cameras of the 6 by 6 cm type, the distance has usually been satisfactorily rendered when included within the depth of field. Moreover, the question is largely an individual one—how much sharpness in the distant scene do you demand; that is, how much sharpness would you consider satisfactory? Such personal tastes must always be considered in connection with photographic problems which involve factors that may be perfection to some and anathema to others.

Q. **I would like to use D-72 developer for roll film but I do not know how much stock solution to use to how much water. Some of my friends have told me to use 1 to 2 and others 1 to 4.—B. G.**

A. For film development D-72 is normally diluted one part stock to two parts water, the same proportions being used with contact papers. The dilution of one part stock to four parts water is for use when developing bromide (enlarging) papers. These are the standard dilutions although individual workers desiring less or greater contrast than the normal afforded by the recommended solutions sometimes use less water than that indicated, resulting in greater contrast, or more water for less contrast. One worker dilutes D-72 in tank film development as much as 1 to 14 and 1 to 16, although the time of development is, of course, prolonged thereby.

Q. **Can you tell me the difference between a Rapid Rectilinear and an Anastigmat lens?—A. R. P.**

A. The principal difference between the Rapid Rectilinear (so called because it reproduces straight lines as straight, an effect not possible with the single lens) and the Anastigmat is that the latter is a fully corrected lens while the former is only partially so. The R. R. lens, as it is generally known, is composed of two single lenses with a stop or diaphragm in the space between them. Each of the lenses of the R. R. is really a long focus lens twice the focal length of the two lenses combined. The R. R. for this reason has been called the cheapest convertible type lens, although the effective aperture of one of the single lenses when used alone is only half that of the combined lens, requiring, therefore, four times the exposure of the complete objective. The chief advantages of the R. R. over the single lens consist merely in the greater speed of the R. R. and its capacity of rendering straight lines rectilinear. The Anastigmat, however, is free of astigmatism, the defect which makes a lens (or the human eye) incapable of focusing sharply, at the same time, lines running in different directions on a plane surface. The Anastigmat, which is free of other lens faults, is the most highly corrected lens commercially available today; it gives a sharper image when used at full aperture than is possible with the R. R. lens even with the latter stopped down.

Q. **Can a miniature camera take a picture from a considerable distance and by enlarging the negative bring out a detail (such as a license number on a car) which the taker of the picture could not see with his naked eye at the time the picture was taken, assuming excellent eyesight? My position is that the result could be obtained if a fine enough lens and film were used and the negative enlarged, subject only to the limitations of the grain on the film. The contention of the person with whom a dispute regarding this point took place was that no image could be received on the film which the naked eye could not receive at the same time and that an enlargement would not improve the result. His contention was that the only way that the result could be obtained was by the use of a telescopic lens.—L. C. D.**

A. One of the principal factors to be contended with in connection with your discussion is the presence of atmospheric haze and the possibility that this will cause a veiling of detail in distant objects. However, for the sake of the argument, you probably would concede the use of a contrast filter in order to facilitate penetration of the blue haze. While we have not had occasion to make an experiment such as that which would be necessary to settle your dispute, we should say off-hand that unless one employed a lens with a circle of confusion greater, a film emulsion with a grain finer, and a film developer affording fine grain results more grainless than anything now available on the market, such a detail as a license number at a great distance could not be revealed in a great enlargement. With present facilities, even if the detail could be enlarged to the enormous degree that would be required under the circumstances, there would be such diffusion of fine detail that the latter would be lost. Much depends, of course, on the focal length of the lens employed; the longer the focal length the better your chances of defining detail at great distances, the use of a proper filter to penetrate haze being assumed.

Q. **In your answer in June to a question by J.J.M., Jr. covering a schedule of U. S. Scheiner ratings for films, you list Verichrome as 20 degrees for daylight and 16 degrees for Tungsten, Kodak S. S. Pan as 23 degrees and 20 degrees, and so on. Kodak and Agfa film obtainable in Mexico is marked 18/10 Din or 28 degrees Scheiner. In setting photo-electric meters, should these ratings be taken into consideration? In other words, when using Verichrome, for instance, should the film sensitivity be adjusted at 28 degrees Scheiner or 18/10 Din in the meter? Why is the rating given on the film set at 28 degrees when, according to the above mentioned answer, it is much lower?—R. J. A.**

A. The rating you cite for Verichrome is evidently that of the European Scheiner System, which gives much higher ratings for the same film emulsions than those published in the United States. In this particular case, the difference is actually eight degrees higher than the rating in the United States. This is almost eight times the speed, requiring only one eighth the exposure, of the U. S. figure. No wonder you are puzzled! However, it makes little difference in the end if your meter is calibrated for the European ratings, as we imagine yours must be. Exposure meters imported for use in the United States are calibrated for the rating employed here and the U. S. Scheiner ratings, therefore, apply for films that are available in the United States.

Books

SELECTED BY THE EDITORS

THE HISTORY OF MOTION PICTURES

By Maurice Bardèche and Robert Brasillach

LITTLE more than 40 years covers the lifetime of the motion picture. In this relatively short space of time it has grown from a novelty to a place of tremendous importance as entertainment, even though its status as an art may be disputed. The present-day advanced product is so far removed in technique from its earliest ancestors that it is indeed fitting to present an historical survey of the entire field. The authors have done a workmanlike job in the present book, gathering material which is presented in clear-cut periods—birth of the film, pre-war films, World War films, the emergence of an art, the classic era, talking pictures. Those who have seen motion pictures during a period of 20 years will revel in the reminiscences which the present book brings forth; younger generations will read it for the romantic background which it affords. (412 pages, 6 by 9 inches, photographic illustrations.)—$4.20 postpaid.—*A. P. P.*

OUR COUNTRY, OUR PEOPLE, AND THEIRS

By M. E. Tracy

IN speaking of differences in the standard of living, in the earning power, in the production, banking, resources, and so forth of other countries as compared with the United States, facts are far more potent than generalities. This *is* a potent volume for it compares all the major features of the United States with other great powers, showing in dramatized graphs all the details that make our particular brand of civilization a more livable one in many respects. Some of the subjects covered are area, resources, population, agriculture, mining and manufacturing, business and trade, finance, transportation, education, health, crime and penology, human rights, and other vital subjects. Interesting *per se*, this volume is also important as a constant reference. (120 pages, 10½ by 13¾ inches.)—$1.90 postpaid.—*F. D. M.*

ASTRONOMY

By W. M. Smart, Prof. Astron., Univ. Glasgow

A SHORT treatise covering only the salient features in a territory which is usually covered in full-length textbooks. Suitable for beginning readers of astronomy who wish a rapid survey in order not to lose themselves at the outset in the mazes of detail. Not, however, in any sense juvenile. The author is a very good explainer. (158 pages, 5¼ by 8½ inches, 38 drawings, 24 excellent plates.)—$1.65 postpaid.—*A. G. I.*

SURVEY OF JOURNALISM

By George Fox Mott and Twelve Co-Authors

"WHY Don't You Write?" This volume is almost an answer to that question so often seen in the advertisements. The authors have taken various subjects in the field of journalism, analyzed them thoroughly and have given us, for example, "Journalism as a Vocation," "The Evolution of Journalism," "Police Blotter Stories," "Revealing the World of Business," "The Newspaper Sets Its Policy," "Making Journalism Pay Dividends," and several other pertinent chapters. It is recommended reading for all who write or want to write. (376 pages, 5½ by 8½.) $2.15 postpaid.—*F. D. M.*

PICTURE MAKING WITH PAPER NEGATIVES

By Nowell Ward

AMATEUR photographers who have never experimented with the production of artistic prints through the medium of the paper negative will find here a doorway opening on a whole new field of photographic enjoyment. Complete directions are given for manipulative technique -balanced lighting, exposure, development, and so on. Troubles are anticipated and suggestions for overcoming them are given in the "Trouble Bureau." (88 pages, 7¼ by 10¼ inches, illustrated with photographs, many of them comparisons of results achieved.)—$1.40 postpaid.—*A. P. P.*

ASPECTS OF SCIENCE

By Tobias Dantzig, Prof. Math., University of Maryland

SEVERAL years ago this author's book, "Number, the Language of Science," attained a wide distribution and the honor of universal praise from men of science. His present volume deals with the philosophy of science—causality, number, the infinite, the quest of the absolute, the straight and the flat, models, universes of discourse, and so on. (285 pages, 5½ by 8¼ inches, 6 illustrations.)—$3.15 postpaid.—*A. G. I.*

VALID OR FORGED?

By Lloyd L. Jones

AS criminology becomes more and more scientific, we are learning that writing either by hand or by typewriter has many secrets which are easily unfolded to the careful investigator. This book compacts a tremendous amount of information regarding such investigations into the space of 168 pages. It tells how the age of inks and papers is determined, how specific typewriters may be identified by the letters they make, how letters written by hand are disguised, how erasures invisible to the eye are discovered, and numerous other problems which require modern equipment. Some of this modern equipment is described and illustrated. This book is intended as an assistant to lawyers, bankers, cashiers, credit men, and insurance officials. (5¼ by 7½.)—$2.15 postpaid.—*F. D. M.*

AMERICAN WINGS

By Captain Burr Leyson

FROM parachute diving to aerial photography, from military tactics through sport flying to commercial aviation, the present book tells the informal story of flying in the United States. Well authenticated in every respect, the material makes exciting reading for anyone who has the least interest in aviation. The photographs alone, most of them full page size, give a thorough grasp of many aspects of present-day flight. (216 pages, 6 by 8½ inches, 40 illustrations.)—$2.15 postpaid.—*A. P. P.*

FIGHTING FOOLS

By James E. Edmonds

SOME people will not like many of the truths presented in this volume which the publisher calls "an impassioned and informed plea that America may be ready and disciplined; that not again shall we wage war like 'fighting fools.'" In it the author discusses in rather complete detail the military history of the United States from the beginning. At many points he notes that we have been entirely too swaggering and boastful. He says that we have been a truculent, touchy, land-grabbing people. His book is not, however, pacifistic in any sense of the word. It is, rather, a tabulation of lessons learned through our failures, our blunders, and our inadequacies in former wars. The serious student of such matters will have many pet delusions shattered through reading this volume, but the end result will be good if it achieves its purpose in showing us what to do and what not to do to maintain peace in the future. (373 pages, 5½ by 8½.)—$2.65 postpaid.—*F. D. M.*

IMMORTALITY

By W. G Langworthy Taylor

A LENGTHY volume which discusses in a calm, quiet, well-poised, philosophic manner the question of survival after death in some of its vital, moral, and physical aspects. While the author is definitely committed to a belief in survival, he also has some strictures to hand out to a certain naïve type of spiritualist. He is obviously familiar with the present background of physics and the philosophy of science. Possibly it boils down to this: most persons who already believe in spiritualism will like this book, and most others probably will not. (626 pages, 5¼ by 8 inches, no illustrations.)—$3.70 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

STEP up to the 2500-pound, 12" telescope shown in Figure 1 and wrap your digits solidly around those two axes, each 2⅝" in diameter, and get the feel of them. Try shaking them. Then run your hand over the two castings, each about like an elephant's leg, which surround them. Ruggedness. This reflector, as described at our request by one of the group which co-operated in the construction, "was designed and built by Frank J. Wanderer, for the use of the Amateur Astronomers' Association of Bergen County, New Jersey, members of the association assisting at various and sundry times. Mr. Wanderer is treasurer of the association. Much of the work on the mirror was done by J. A. McCarroll, president of the same association, whose interest and general assistance aided materially. Patterns were made by H. L. Barnes, vice-president. Other members who lent notable aid in the construction were John Lennon, S. E. Haines, R. Gilcher, O. P. Morrow and Marinus Rose. William Goehner, also a member of the association, machined with great precision all of the castings in his shop—The Jersey City Welding & Machine Co.

"The mirror is a 12" x 1½" plate glass porthole light. Focal length, 93". It was ground by machine (made by Wanderer and Lennon) and figured by hand and machine by McCarroll.

"Lattice design of tube needs no comment. Tube rotates in saddle on 24 bronze rollers attached to tube. Three long rods (through roller axles) are for adjusting the mirror axis in proper optical line-up. Mirror has three-point adjustable flotation pads. (See Hindle, 'ATM,' 4th ed., p. 229.) The three short rods with wheel handles are for slow motion in R. A., declination, and clamping in declination. Clamp in declination is a bronze brake-band around declination housing operated by gears. Declination slow motion is by gears to declination housing. Rough adjustment in declination overhauls gears. Right ascension control is designed to operate by a flexible shaft—not so good and will be changed.

"Prism is 2¼". Is secured by a 3-arm spider and is adjustable in all directions. Three finders make sky-scraping easy.

"Mount consists of three heavy castings, a flange casting to take the ¼" plate saddle and two 6" x 20" castings for the polar and declination axes. The shafts are 2⅝" cold-rolled steel, set in ball bearings at both ends of housings. Job is as solid as the Rock of Gibraltar.

"The bearing on top of the pedestal is a rocking device. It allows adjustment in latitude from 37° to 48°. A threaded adjusting rod with wheel is attached to the underside of the polar axis and a calibrated dial shows the latitude.

"Circles are brass bands, ¼" x 1", etched by hand. Declination reads to 5 minutes of arc and right ascension to 15 seconds of time by means of verniers in each case.

"The equatorial system was the brain teaser, with very little simple and available precedent to go on, but the final result has turned out entirely satisfactory. The R. A. circle is adjustable to sidereal time, as suggested by Porter in 'ATM,' but the adaptation is only remotely related in detail. Two verniers are required for the R. A. circle, one for sidereal time and one for setting in R. A. Simply take R. A. out of the Ephemeris and set instrument at once to sidereal time, which can then be read directly like a clock any time while the instrument is in operation.

Figure 1: Made in Bergen County, N. J.

"Drive is by a $\frac{1}{40}$ H.P., 1800 r.p.m. synchronous motor (in pedestal) with reduction gears, including a 1½" worm to a 4" *standard spur* gear wheel at bottom of worm rod. The latter drives the 15" aluminum worm gear disk on shaft.

"The large gear disk and the R. A. circle are mounted on a collar or hub which can revolve on the polar shaft. The worm disk is permanently secured to this hub, and the R. A. circle is adjustable on this by set-screws. R. A. circle is set to sidereal time vernier and is then clamped in place. Pressure screws attached to shaft force a ring up against the hub which, in turn, forces the hub up to engage a friction clutch on shaft just below the end of the polar housing. Rough adjustment can be made at any time, the shaft revolving in hub through the slight friction of clutch.

"The worm rod is a ⅝" ordinary round drill rod with a standard thread, machined, and the worm gear on the aluminum disk was cut by the thread on a hardened rod. It works!

"Pedestal is a 'Center Street Model'—of unknown lineage. A lucky break at a very nominal expense. [Center St., New York—second-hand machine equipment hunter's seventh heaven.—*Ed.*]

"The electric equipment (not fully shown) will include a small lamp and hood with switch at R. A. sidereal time vernier. Another lamp will be on the declination vernier. A red pilot light (not visible in photo) is installed to indicate running of motor. Plug for cable is shown under gear bearings on pedestal.

"The whole assembly weighs 1¼ tons and is mounted on a truck running on a track. 'Scope is housed in one of the garages shown in the background and when in use it is run out on track to a platform having a floor just under the counterweight. This is a 22-gage sheet metal container filled with concrete and steel plate punchings.

"Since the photograph was made a lining has been installed inside of the tube at eyepiece end to cut off extraneous light, which was found to be very troublesome, from nearby street lamps.

"Mirror was 'axed up' by McAdam's method—with some presumed improvements. We made a 'B' disk ('ATMA,' p. 272) with a 4" dia. hole with cross threads to line up with pin-hole from 'A' disk. We found it impossible to sight through two small holes so far apart—8'.

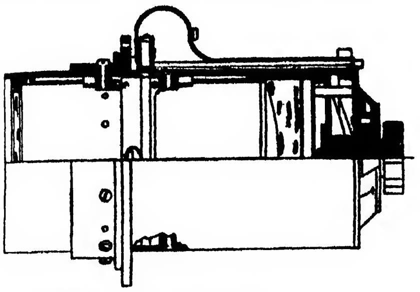
"The job has taken exactly three years to complete, working at odd times outside of business hours. Performance is entirely satisfactory. Of course we have improvements contemplated for the 'next one'."

ON page 74 of this number Professor Russell describes the Struve spectrograph and mentions a Schmidt camera, shown on that page only as a small bump on the big instrument. Amateur telescope makers will take further interest in this Schmidt camera, especially as it is the same one that was made for Yerkes Observatory by C. H. Nicholson, of DuQuoin, Ill., a member of the Amateur Telescope Makers of Chicago and described in this department in December, 1936. Therefore we present Figure 2, taken from *The Astrophysical Journal* for December, 1937, because it shows the camera in section. Its focal ratio is 1, its mirror is 110 mm (4¼") in diameter and the correcting plate is 3¾" in aperture. The mechanical parts of the design are by Dr. G. W. Moffitt, now of Perkin, Elmer and Moffitt, optical designers and consultants, New York.

MARKING mirrors is the subject of the following note which rounds up considerable research done by Fred M. Gar-

land, vice-president of the Astronomical Section of the Academy of Science and Art of Pittsburgh (the Pittsburgh club of amateur telescope makers). If a hospital nurse can accidentally give a mother back the wrong baby, so may mirrors be mixed up. He writes:

"Sometimes an amateur sends his mirror away to be aluminized, and then can't quite make up his mind whether the mirror he



Courtesy *The Astrophysical Journal*
Figure 2: The Schmidt at Yerkes

gets back is his own or not. The usual method of identification is knowing your own pet little chips (if any), or a small sleek at say 9 o'clock. If, however, your mirror is without chips and sleeks, here are a few suggestions that may help if you desire to identify permanently the ownership or maker's name:

"HF, hydrofluoric acid, is chiefly used for etching designs and markings on glass. The glass is first coated with a film substance impervious to HF, like wax, paraffin, and so on. The desired markings are then cut through the coating with a scriber or sharp instrument, the glass is exposed to the HF or dipped into its solution; and, upon removing the coating, the marks are found etched on the glass. The vapor of HF leaves opaque and white tracings; the solution leaves transparent lines. HF is a strongly penetrating corrosive and care must be used in handling. [It is poisonous, the fumes are dangerous, and good ventilation during its use is recommended.—*Ed.*]

"Silver ink, black or white glass marking ink, monogram inks, frosting solutions and glass etching materials may all be bought on the market. Precautions are necessary to avoid acid burns or destroyed clothing. Good ventilation must be maintained; properly inspected rubber gloves will help to protect the skin from painful irritation caused by contact with some of the chemicals. The trouble is that, with many solutions of this kind, the glass must be heated to complete the process, and that is too much of a risk for the amateur before or after his mirror is ground. With a glass tumbler or electric light bulb any slight stress, such as is set up by such heating, will make no difference, and marking articles of that kind with chemical preparations is entirely another matter.

"The experience of some amateurs and at least two large glass manufacturers may be of value to the reader. Several methods of marking the back or side are given:

(1) Sharpen an old dentist's tool and use it as a scriber or etching pencil for fine lines.

(2) Diamond point pencils, or carbon points used in a pin vise, may be bought on the market, and leave a well defined mark.

(3) Vibrating electric pencils may be purchased on the market; electric power is required, as is careful manipulation, since the tool is usually heavier than those mentioned in (1) and (2). A small electric hand

grinder, employing tools to cut or engrave, may be used.

(4) Sodium silicate (water glass) may be purchased at paint or feed stores. There is enough in a ten-cent can to mark hundreds of mirrors. This may be applied with a steel pen and will last a long time if protected. If the back or side of the disk is ground, the sodium silicate will etch into the glass and leave a permanent mark even after the sodium silicate has dried up. Also red or blue tallow or grease pencil marks will adhere to the glass and may be preserved by covering with a brushing of sodium silicate.

Figure 3: Wysor observatory

"After making many tests, the writer would recommend to any amateur the process used in (1): just scratch—that word sounds bad—just etch, not too deeply, your initials, date, or any identification mark, on the side of your mirror before you start grinding; or, if the side is to be rough ground, mark it after grinding—the scriber will leave a deep enough mark for the purpose intended."

Pursuing the policy followed in "ATM" and "ATMA," of naming names and giving addresses when publishing data like the above—that is, data about odd materials for which the isolated amateur would find difficulty locating sources—we asked Garland to give us the addresses and he writes:

"Diamond point pencils may be procured from the Arthur H. Thomas Co., 230 7th Street, Philadelphia, Pennsylvania; Carborundum pencils are furnished by the L. S. Starrett Co., Athol, Massachusetts—the body of the pencil is nothing more or less than a small pin vise—and Carborundum points are made by the Carborundum Company of Niagara Falls, New York. Tallow pencils are made by the Joseph Dixon Crucible Co., Newark, New Jersey; the trade name of the pencil is Dixon's Phano. Or one may be obtained from most hardware stores by asking for a pencil to be used on glass surfaces. One type of vibrating pencil is called 'Engrav-Rite' and is furnished by the Quality Merchandise Co., 2306 Lincolnwood Drive, Evanston, Illinois; or an electric engraving 'Handee' tool manufactured by the Chicago Wheel & Mfg. Co., 1101 West Monroe Street, Department E, Chicago, Illinois, may be used.

"Silver monogram ink, black monogram ink, glass frosting solution, and glass etching solution are furnished by the Westinghouse Lamp Division, Westinghouse Electric & Manufacturing Co., Bloomfield, New Jersey."

CLEAN design is a characteristic of equipment shown in Figures 3 and 4, owned by D. C. Wysor, 136 Brookside Avenue, Ridgewood, N. J. The observatory (Figure 3) is 15′ x 15′, with 7′ walls. Its roof rests on four roller-bearing flanged wheels, and by means of a winch and cable it can easily be rolled off on a steel track at one side, giving an unobstructed view. The telescope (Figure 4) is a 12½″ f/9.5 with a tube made of Johns-Manville Transite pipe—so far as is known, the first time this material has thus been used. It has .52″ walls and 14″ I.D., weighs 220 pounds and is very rigid. The cell was made by J. J. McGuckin, of Ridgewood, and has three bayonet joints. The pedestal is of 6″ pipe bolted to a 2-ton concrete pier. The mirror was made by Wysor at the astronomical workshop of the Hayden Planetarium, in New York, under the direction of Ramiro Quesada. The mounting proper is one of McCartney's "H.H." types, made for Wysor by E. B. McCartney, of Hempstead, N. Y. The drive is a 12-watt Telechron motor, controlled by a Bodine reversible motor with push-button control, which rotates the motor backward or forward for guiding at about 80 percent of sidereal rate.

TWO high school principals have sent us photographs of their telescopes. Figure 5 shows that owned by Principal J. Russell Smith, Smyer H. S., Smyer, Texas, who made the optics but obtained the mounting from H. L. Armiger of Detroit. Figure 6 shows the telescope made by Principal Theo. Skonnard, Fort Ransom H. S., Fort Ransom, N. Dak. Both are clean, smooth pieces of design.

Figure 4: The Wysor telescope

IF you daub shirts, handkerchiefs, your hair, table linen and bed linen with rouge during your struggles with mirror making, you may be providing somebody with legal grounds for divorce for cruelty. However, as Everest states in a private communication, "if a man is slobbering himself all up with rouge he is probably getting sleeks and scratches also. Anyone who carries rouge from the lap to his clothes will also carry dust and grit from his clothes to the lap. If the necessary care is used during pitch polishing, one can even work in full dress without becoming untidy. In 'ATMA' I mentioned the need of becoming grit conscious, but probably didn't make it strong enough. Almost surgical technic is required, but it becomes second nature after some experience and is absolutely necessary with pitch."

F. C. Gebhardt, 140 East 29 Street, Erie, Pa., states that he has used Bentonite, often called "mineral soap" or "soap clay," for removing old rouge spots on white shirts and, while this took considerable elbow grease, it worked. Your scribe therefore obtained some of this peculiar clay material and similarly found it accomplished much with an old smock that bore many superimposed strata of rouge daubs dating back

Figure 5: Principal Smith

toward the pre-Cambrian. Bentonite is obtainable from the Eastern Clay Products, Inc., Eifort, Ohio, in one-pound packages, for less than the price of one shirt. Mix it with soap granules, ten parts soap to one part Bentonite. The soap will generally prevent the Bentonite from settling. The cleansing action is one of simple adsorption, due probably to the high surface area of this colloid (particles 1/25,000,000" to 1/50,000" in diameter). Laundries use a great deal of Bentonite, and it is also used in many diverse ways in many other industries not related to cleansing. It is a clay obtained mainly from the Fort Benton (Upper Cretaceous) shales of Wyoming, and is not a "chemical."

RFT fiends should alter *d* to *a*, in line 6, column 2, page 50, last month's number; also alter "eyepiece," in analogous position on page 52, to "object glasses," and add "corresponding to the well-illuminated field of view of a Galilean curiously depending on size of objective"—so Walkden writes.

Since last month John M. Pierce has prepared one of his Hobbygraphs on the RFT, containing much compact working data.

LAST call to Stellafane convention, atop Mt. Porter, near Springfield, Vt., Saturday, August 6. As this goes to press (June 21) Russell W. Porter writes that he is "highly likely" to be present.

Figure 6: Principal Skonnard

CAMERA CATALOGUE, 36 pages, 7 by 10 inches in size, is designed to be of interest not only to dyed-in-the-wool camera fans but also to serve as a helpful guide to newcomers in the hobby. Besides a listing of a wide selection of cameras and photographic supplies, there are included charts giving lens speeds as well as correct films and lighting for use under varying conditions. *Wholesale Radio Service Company, 100 Sixth Avenue, New York City.—Gratis.*

EYE PROTECTION GUIDE is an illustrated circular showing those industrial jobs that endanger the eyes and telling what type of goggles will give the surest protection under working conditions. The chart covers all principal industries. *American Optical Company, Southbridge, Massachusetts.—Free to industrial concerns upon request.*

ELEVATOR ROPE is a 32-page catalogue which gives details of rope construction and recommendations as to those ropes best suited for different types of elevators. Also included are detailed instructions regarding the proper methods of handling and installing wire ropes. A comprehensive section deals with factors affecting to a greater or lesser degree the life of elevator ropes—lubrication, improper counterweights, and so on. *Broderick & Bascom Rope Company, 68-70-72 Washington Street, New York City.—Gratis.*

HOMES FOR BIRDS describes in detail the construction of various types of bird homes for attracting wild life for economic as well as for esthetic reasons. Illustrated with a number of constructional drawings. Farmers' Bulletin No. 1456 of the U. S. Department of Agriculture. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

FARM FENCE HANDBOOK, by Henry Giese, is a 64-page illustrated catalogue showing in the introduction various types of fences, from crude piles of boulders to woven wire. It then deals with the modern fabrication of wire for fencing and its application to various types of usage. For distribution to students and farm organizations only. *Hill and Knowlton, 1454 Builders Exchange Building, Cleveland, Ohio.—Gratis.*

DISPOSAL OF REFINERY WASTES presents in convenient form information designed to promote the adoption of approved principles and practices for disposing of poisonous and malodorous wastes from oil refineries. It is written especially for refinery executives and engineers. *American Petroleum Institute, 50 West 50th Street, New York City.—50 cents.*

MICROMAX FREQUENCY RECORDERS AND INDICATORS is a 20-page booklet which shows the increasing importance of frequency measurement to public utilities and industrial plants, largely brought about by the increasing use of synchronous clocks and synchronous machinery. Various instruments for frequency recording are illustrated and their uses described. *Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

A NEW FINISHING SYSTEM FOR ARCHITEC TURAL IRON AND STEEL PRODUCTS describes Bonderizing, a rapidly applied under coating which promotes paint adhesion and affords protection from rust. It is applicabl to a wide range of architectural units, from screen frames to air-conditioning equipment from home medicine cabinets to steel win dow hardware. *Parker Rust-Proof Company Luke and Rice Streets, Detroit, Michigan —Gratis.*

USE OF CONCRETE ON THE FARM give formulas for mixing concrete for far structures, which vary according to the u to which the concrete is to be put. Factor other than composition, which are requisit for strength, watertightness, economy, ligh weight, and resistance to wear, are also di cussed. These factors include consistenc methods of mixing, manner of depositin and the care of newly placed concret Farmers' Bulletin No. 1772. *Office of In formation, United States Department Agriculture, Washington, D. C.—Gratis.*

HOW TO EXPOSE KODACHROME is a hand vest-pocket size guide for use in both sti and motion-picture photography. It giv complete details for achieving the best po sible results with this color film and includ a convenient "conversion dial." *At your ph tographic dealer or direct from Eastm Kodak Company, Rochester, New York.— 50 cents.*

ULTRA-VIOLET FLUORESCENCE is a singl sheet bulletin which describes an i expensive outfit for producing ultra-viol light for use in experimental work. It al tells how this light may be applied in t study of many materials. Prices of the equi ment are quoted. *Harry Ross, 82 W Broadway, New York City.—10 cents.*

SYSTEMATIC LOCATION OF DIESEL ENGI TROUBLES, by Victor W. Pagé, is a lar folded chart (38 by 25 inches), printed two colors, showing the construction of typical engine and its fuel system. It o lines all troubles causing lost power, m firing, hard starting, and so on. *The Norm W. Henley Publishing Company, 2 W 45 Street, New York City.—50 cents.*

SAFE USE AND STORAGE OF GASOLINE A KEROSENE ON THE FARM, Farmers' B letin No. 1678, points out the most comm hazards and the precautions which sho be observed. It also gives information extinguishing gasoline and kerosene fi *Superintendent of Documents, Washingt D. C.—5 cents (coin.)*

THE CASE FOR FREEDOM FROM FEDE CONTROL OF WAGES AND HOURS is statement of a conviction rising from will to perpetuate individual and indust freedom. Continuation of this freedom desirable; from it has sprung our ra economic and social progress. *Machin and Allied Products Institute, 221 No La Salle Street, Chicago, Illinois.—Grat*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

GIN AND MILK

THE Court of Customs and Patent Appeals has held that gin and milk are not goods of the same descriptive properties and we are pleased that we are confirmed in our opinion that we should not feed gin to our baby.

A distiller of gin sought to register the trade mark "GOLD CROSS" as applied to his merchandise. A milk products manufacturer who owned the same trade mark as applied to canned milk and cream opposed the registration on the grounds that his business would be damaged. In support of his contention the milk products manufacturer stated that customers who were prohibitionists would be antagonized by the fact that the same trade mark was applied to gin. It was also argued that the drinkers of gin would purchase "GOLD CROSS" gin, believing that it was a product of the milk products manufacturer. The Court rejected this contention, pointing out that milk and gin were not goods of the same descriptive properties and that the injuries claimed by the milk products manufacturer were too indefinite and remote to justify refusing to register the trade mark for gin.

DOUBLE-EDGED

WE have discussed from time to time on this page the so-called "Fair Trade Laws" which permit a manufacturer to fix by contract the re-sale prices of merchandise bearing the manufacturer's trade mark, brand, or label. Under most of the fair-trade laws, knowingly selling merchandise at prices lower than those fixed by contract constitutes unfair competition.

It appears from a recent decision in New York that the fair-trade laws are a double-edged sword and that the manufacturer cannot claim exemption from the provisions of a contract fixing the re-sale prices at which his customers may sell his merchandise. In the case in question a prominent razor manufacturer sold razor blades to both the retail and wholesale trade. The manufacturer charged the same price to both wholesalers and retailers, less discounts of 13 percent and 2 percent. However, retailers were allowed an additional discount of 8 percent for so-called "retail sales displays and promotion," whereas the wholesalers were only granted a discount of 3 percent for so-called "wholesale sales promotion."

One of the wholesalers who sold the razor manufacturer's products sold the products at a price lower than that specified by the manufacturer and the manufacturer brought suit to enjoin the wholesaler from advertising, offering for sale or selling the products at prices lower than the specified prices. The wholesaler raised the defense that the manufacturer was not entitled to the protection of the so-called "Fair Trade Law" for the reason that the manufacturer was selling merchandise to retail dealers at lower prices than to wholesale dealers and therefore the manufacturer was guilty of the very act of which it complained. The manufacturer took the position that the Fair Trade Act was not intended to apply to manufacturers and that accordingly the price at which it sold its merchandise to retail dealers was immaterial. The Court rejected the contention of the manufacturer and held that by reason of the manufacturer's acts in selling to retailers at prices lower than those at which the wholesalers were required to sell to the retail trade the manufacturer was not entitled to any relief. In this connection the Court stated:

"The Court is unable to agree with the position taken by the plaintiff. The benefits which it was designed to create by the enactment of the Fair Trade Act would be practically nullified by permitting a practice under which the plaintiff could compete with the defendants and undersell them while requiring them to maintain a stipulated wholesale re-sale price fixed by the plaintiff. The mere fact that the plaintiff refers to itself as a manufacturer does not warrant it in going into unfair competition with the defendants."

MADONNA

THE Court of Customs and Patent Appeals has refused to register the trade mark "Madonna" as applied to wine, on the grounds that it is scandalous.

A wine producer adopted and used the name "Madonna" as a trade mark for wine and sought to register the trade mark in the United States Patent Office. Registration of the mark was refused by the Patent Office tribunals on the grounds that it was scandalous and an appeal was taken to the Court of Customs and Patent Appeals. The Court sustained the Patent Office tribunals, pointing out that the name Madonna was generally understood among English-speaking peoples to refer to the Virgin Mary or to a representation of the Virgin Mary. The Court then pointed out that "the Virgin Mary stands as the highest example of the purity of womanhood, and the entire Christian world pays homage to her as such. Her representation in great paintings and sculpture arouses the religious sentiments of all Christians."

The abuses and excesses associated with alcoholic beverages was considered by the Court and it concluded that many people would be shocked to see the name "Madonna" displayed, among other places, in barrooms. The reasoning of the Court is succinctly set forth in the following quotation from the opinion:

"In our opinion, to commercialize the name of, or a representation of, the Virgin Mary as a trade mark is of very doubtful propriety, and we feel certain that its use upon wine for beverage purposes would be shocking to the sense of propriety of nearly all who do not use wine as a beverage, and also to many who do so use it; therefore, we think such use of the word 'Madonna' would be scandalous and its registration prohibited under said trade-mark act."

It is interesting to note that there was a sharp dissenting opinion by two of the Justices of the Court, in which it was pointed out that wine was an ancient and honorable beverage. The dissenting opinion stated in part: "Ordinary wine is used as a common and usual beverage by multitudes of our people instead of water. The Savior changed water into wine at the behest of His Virgin Mother at the wedding feast; it was used at the Last Supper, and, as a matter of common knowledge, it is a part of the very core of the most sacred religious rites of many of both Christian and other faiths."

AMPLIFICATION

IN a case of outstanding importance the United States Supreme Court has held that a patentee may grant a license to manufacture and sell a patented article for restricted purposes and in a restricted field, and that if a person purchases the patented article from the licensee with knowledge of the restrictions for use outside of the restricted field he is guilty of patent infringement.

In the case under consideration the plaintiff granted a license to a manufacturer under certain patents for amplifiers, to manufacture and sell the amplifiers for private use only as distinguished from commercial use. The licensee, in violation of the license restriction, sold amplifiers to the defendant who was engaged in the business of leasing talking picture equipment to theatres. At the time that the defendant purchased the amplifiers he had knowledge of the license restriction but he nevertheless leased the apparatus for commercial use.

The questions presented to the Court in this case were not free from difficulty in that it has long been held that where an article has been sold in the ordinary channels of trade it is free from any restrictions that may have originally been placed upon the article by a patentee. In the present case the Court pointed out that the licensee had no right to sell the amplifier for commercial use and that the purchaser knew of this at the time that he purchased the apparatus. It was held that under those circumstances the purchaser of the amplifiers who later leased them for commercial use in violation of the license restriction was guilty of patent infringement

As stated above the case presents questions that are not free from difficulty and one of the justices dissented from the majority opinion. Also it is significant that the Supreme Court has granted a rehearing in the present case and it will be interesting to note what disposition the Court will make in this rehearing.

SCIENTIFIC AMERICAN
ADVERTISERS
August · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President — JOHN P. DAVIS, Treasurer — I. SHELDON TILNEY, Secretary

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Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • SEPTEMBER • 1938

MODERN streamlining and old-fashioned exposed working parts—the joy of romantically inclined persons—combine to make unique the new Hudson type locomotive shown on our cover. Ten of these have been built by the American Locomotive Company for the New York Central to conform to the new, streamlined Twentieth Century Limited. For fast passenger service, they are of 4700 horsepower, an increase of approximately 15 percent over the previous Hudsons. Henry Dreyfuss, noted industrial designer, designed the streamlining.

18985

SCIENTIFIC AMERICAN, September, 1938. Vol. No. 159, No. 3, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1888)

YELLOW JACK—"During the month of August much alarm has existed in Florida, on account of the appearance there of yellow fever. . . . Every means was adopted to check the speed of the fever. Resin and tar fires were built and maintained, in the hopes that the bituminous fumes would kill the bacterial germs. Acting on the theory that concussion of the air would effect the same result, cannonading was extensively practiced."

GRAVITY RAILROAD—"In a new system of operating passenger railroads in towns and cities . . . the locomotive is dispensed with. Hence the railway structure may be very light and simple, offering but little obstruction to the streets. At the stations, it will be observed, there are two undulations in each track, a car approaching the station being carried up and over the slighter elevation of the first undulation, where it stops to discharge and receive passengers, after which it is carried up over the higher undulation beyond, and allowed to proceed on its way to the next station under the action of gravity alone, whereby a high velocity is imparted to the car. Attached under each car is a cable gripping mechanism designed to work automatically: as the car arrives at the end of each long incline, and without at all checking its speed, its gripping mechanism comes in contact with the moving cable, driven at the station, by which the car is kept continuously on its journey till the desired stopping place is reached, which is on a slight incline, when the cable is released. As the car stands on an incline, it starts of itself by the action of a lever."

TELEPHONE—"We can all remember when the telephone appeared and startled us. It was so novel that it was hard to understand how it could be made of practical value, especially as, at that time, with the apparatus at hand, it did not work so smoothly and reliably as now. Practical, pushing men got hold of it, and now we wonder how we could get along without it."

RAILROAD FUEL—"The Philadelphia *Record* says that the problem of obtaining a cheaper fuel than coal for locomotives, which has long bothered railroad men, seems likely to be solved soon by experiments now being made with gas."

OIL—"About 400 barrels of crude petroleum are being turned out daily by the 22 wells of the Pacific Coast Oil Company in the Pico district, near Newhall, California. The wells of the company are now sunk to a depth of from 1600 to 1800 feet. The oil is of the best quality obtained on the coast, and the demand for it is very great. Some of the new manufactories at San Francisco burn oil instead of coal."

KODAK—"One of the latest ideas based upon the dry negative process is the production of an extremely simple apparatus, so arranged that it cannot get out of order and adapted for use by the veriest 'greenhorn.' . . . When a hundred exposures have been made, all the individual has to do is to send the apparatus to the manufacturers, who do all the work of finishing up the pictures. Thus no manipulation whatever is required by the purchaser, save the making of the exposures. . . . The fact that one has a large roll of sensitive material to draw from in making the pictures inspires confidence and freedom, since the exposures may be made rapidly, without previous preparation. . . . The 'Kodak,' for such is the name given to it by the manufacturers, is essentially a portable camera, intended mainly for making instantaneous exposures, but may be used for time work also when a secure place can be found to rest it upon. Its simplicity and lightness are its chief features."

NAVAL SPEED—"The fastest armed cruiser in the world is said to be the German vessel *Greif*, which has a displacement of 2000 tons, and is fitted with engines of 5400 indicated horse power. On the voyage from Kiel to Wilhelmshafen a speed of 23 knots, or almost 27 miles an hour, was obtained. What is the reason our Navy Department does not build some fast vessels like this? Every one of the new ships so far ordered is to be a slow tub compared with the *Greif*. Why does not the Secretary of the Navy use his influence to have some fast vessels constructed?"

PHOTOGRAPHY—"We have received from Mr. W. H. Mowrey, photographer, Milford, Mass., a couple of instantaneous photos of railway trains stated to be moving at the velocity of 40 miles an hour. The details are excellent and the pictures very pleasing."

TRANS-SIBERIA—"According to *Engineering*, the Russian government would appear to have decided to push on the Siberian railway with energy. . . . The object the Russian government aims at in connection with the Siberian railway is not so much to provide the country with a good solid line as to link the Pacific coast with Russia proper, as rapidly as possible, with anything better than the present means of communication."

DEFENSE—"General Brialmont, Inspector-General of Belgian Fortifications, says the defenses of the Meuse are the material guarantee of Belgian neutrality and autonomy, and constitute a line of defense for France. The valley of the Meuse is continued in France by the valley of the Oise, which is not sufficiently defended. The 21 forts which are capable of offering effectual resistance are a barrier closing at the same time the gates of Belgium and those of France."

GLASS CLOTH—"Mr. Dubus Bonnet, of Lille, France, has invented a process of spinning and weaving glass into cloth. The warp is composed of silk, forming the body and groundwork, on which the pattern in glass appears, as effected by the weft. The requisite flexibility of glass thread for manufacturing purposes is to be ascribed to its extreme fineness, as not less than from 50 to 60 of the original strands are required to form one thread of the weft."

AND NOW FOR THE FUTURE

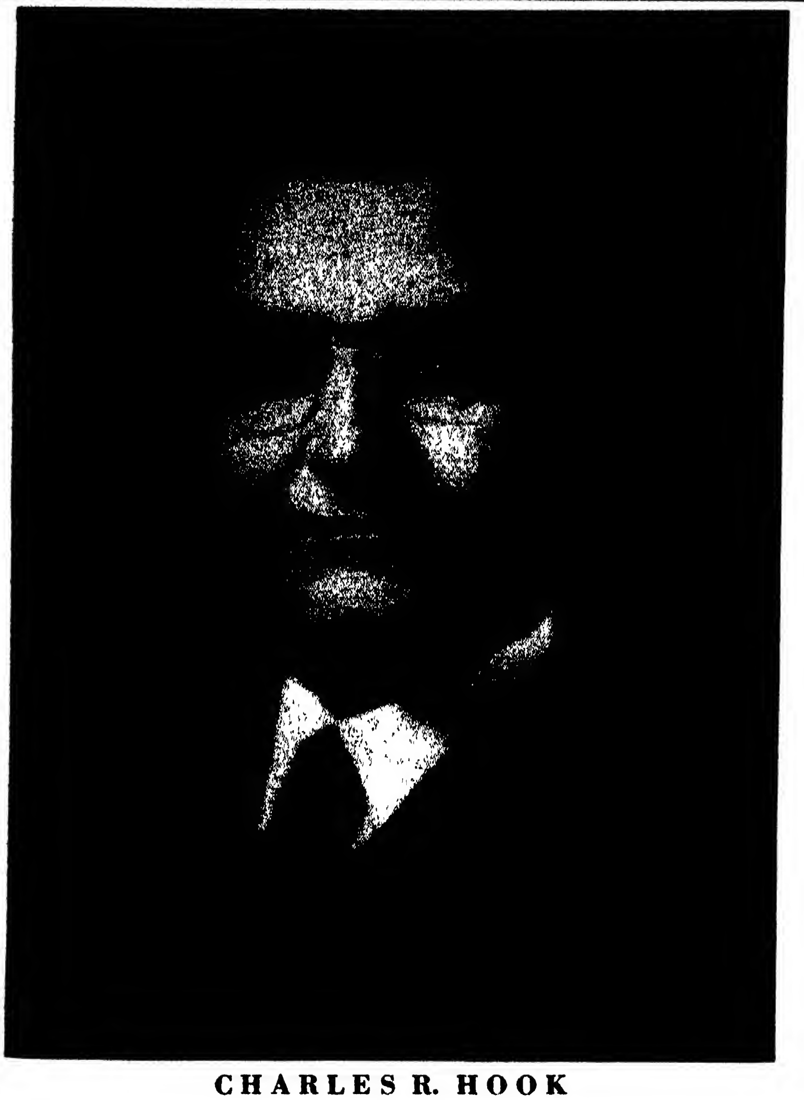
¶Archeology's recent contributions to Homer's story of ancient Troy, by Jotham Johnson, Ph.D.

¶Electrical brain waves may reveal answers to many of the secrets of life, by Barclay Moon Newman.

¶Science on the King Ranch; Nature's obstacles to successful ranching overcome by mechanical equipment.

¶Safeguarding the salmon fisheries of the Columbia River system, by R. G. Skerrett.

Personalities in Industry



CHARLES R. HOOK

THIRTY-FIVE years ago Charles R. Hook, who at 22 was night superintendent of The American Rolling Mill Company's original plant at Middletown, Ohio, went to the employees of the small, young concern and said:

"There are many problems in the managing of this business that you do not understand, and there are many of your problems that we of management do not understand. Why can't we get together once in a while, so you can tell us about your problems and we can explain ours to you? In that way we could learn a lot from each other and that would help us all to keep our jobs and improve our condition."

The men, who had been accustomed to the "hire and fire" attitude which was general in industry at that time, were skeptical at first. But at Mr. Hook's continued urging and repeated demonstrations of good faith, they agreed to a relationship in which the goal was "co-operation" instead of "coercion."

That was the beginning of a series of developments in "human engineering," inaugurated by Charley Hook, that brought about the remarkable spirit of mutual interest between management and men for which Armco is known throughout American industry today. A test of the employees' attitude was made recently at the company's Butler, Pennsylvania, plant, just 30 miles from Pittsburgh. In a consent election requested by the Steel Workers Organization Committee of C. I. O., and conducted by the National Labor Relations Board, employees voted 1242 to 402 to reject the outside group as a bargaining agency in their dealings with the management.

Mr. Hook, who has been president of Armco since 1930, has been successful with workmen because he has the workman's viewpoint, developed when he was a workman himself in the old Morewood Works of the American Tin Plate Company at Gas City, Indiana.

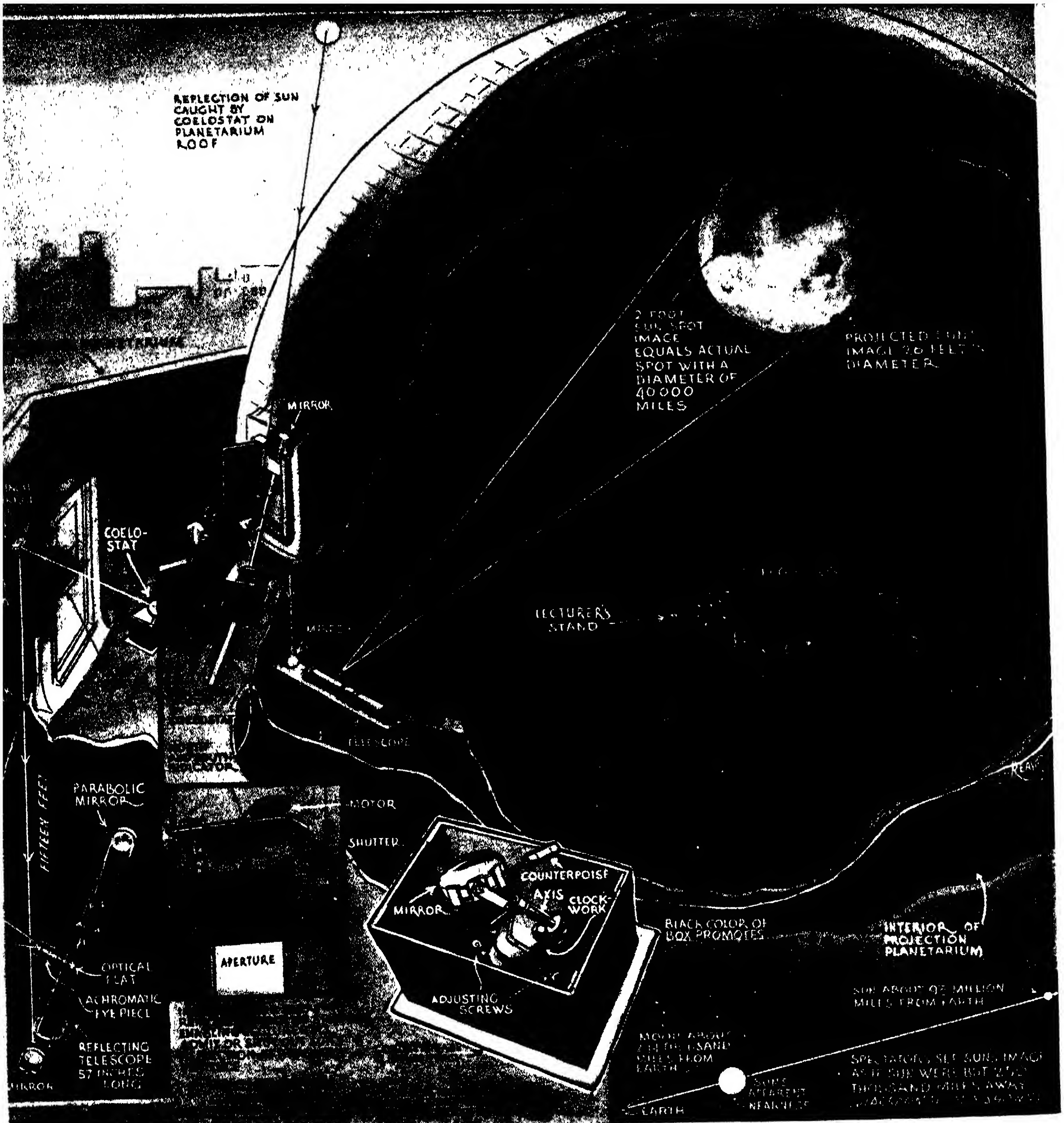
The son of a Cincinnati carriage manufacturer who "lost everything" in a financial panic in the late 'nineties, Mr. Hook, upon graduation from high school, went to work as an office boy for a tin plate concern at two dollars a week.

When the "Trust" bought out the company, he was transferred to New York, and placed in the accounting department. But he realized that if he was ever to get anywhere in the steel business he would have to know something about the practical side of making and rolling steel. So he asked his superiors for a job in one of the mills. The change was a demotion, but he gladly accepted and before going with The American Rolling Mill Company had worked up to the position of roll turner.

When Mr. Hook joined Armco as night superintendent in 1902, he was young-looking and slight of stature. When he went into the plant for the first time the workmen wanted to know, "who's the kid?" But they soon found out that he had a man's head on a boy's shoulders.

Today Mr. Hook is one of the leading men of American industry—an accepted authority on matters pertaining to personnel. He has seen his company grow from small-scale operation, with 325 employees and a monthly payroll of $25,000, to a major steel company, with 16,000 employees and a yearly payroll of $33,000,000 in 1937.

Asked once what his hobby was, he replied, "employee relations," and that pretty well covers it. As vice chairman of the Committee for Economic Recovery he made a long and careful study of housing and housing needs in the United States. He is a member of the Business Advisory Committee, appointed by Secretary of Commerce Roper, and chairman of the Committee on Personnel of the Seventh International Management Congress in Washington this fall. Last January he was elected president of the National Association of Manufacturers, and since that time Middletown, New York, and Washington have formed three points of a triangle which he covers with almost weekly regularity. He carries a young office around with him when he goes, and has the amazing ability to think of, and do, many things well at the same time.

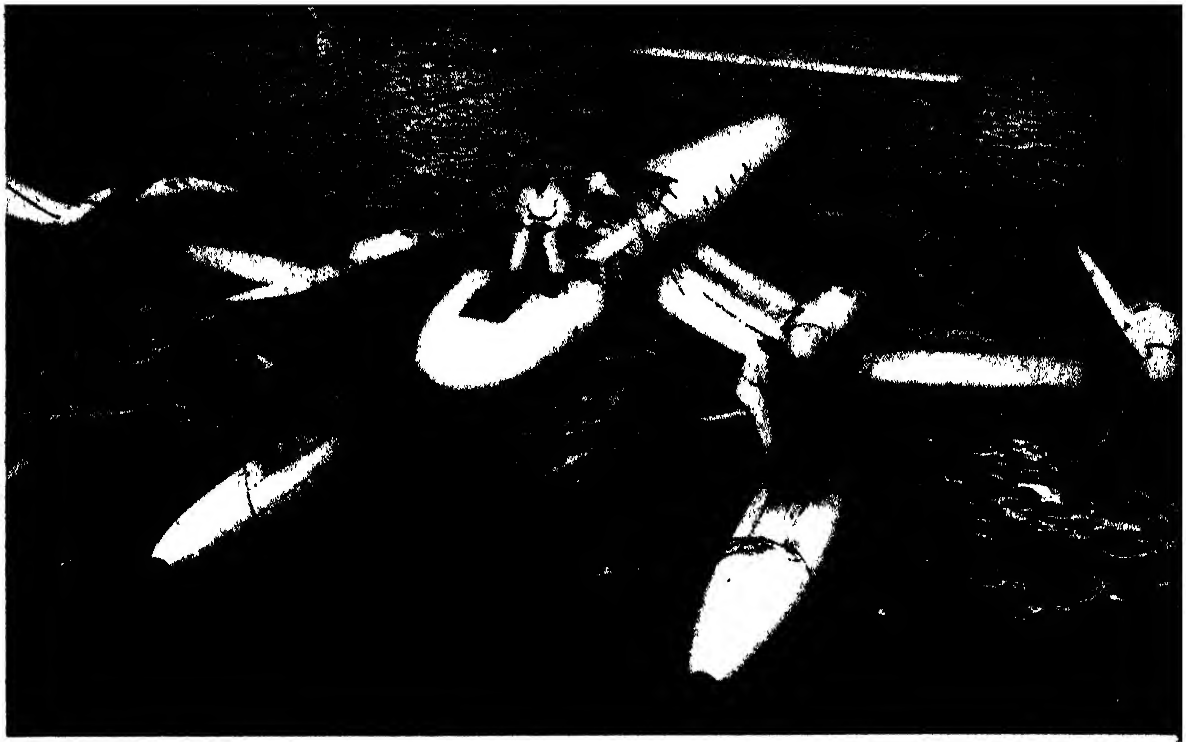


Drawn from the original, by Logan U. Reavis

Bringing the Sun Indoors

At the Hayden Planetarium in New York a huge 26-foot image of the sun is being projected on the interior of the dome every day that the sun shines. This is accomplished by means of a first system of moving and fixed flat mirrors for bringing the sun's image indoors and a second system of mirrors and lenses for enlarging and projecting it.

The actual sun is shown at the top of the drawing. Its rays are caught by an eight-inch flat mirror mounted on an axis parallel with the earth's axis. A clock-like mechanism slowly turns this mirror as the earth's turning "moves" the sun. This image, after passing through an opening in the building, is kept constantly spotted on a second flat mirror which is permanently fixed in position. It in turn passes the image downward to the third element of the long optical train, a flat mirror fixed at a 45-degree angle which turns it horizontally. The sun's image is now where it can be used but as yet it is neither magnified nor projected. Magnification is done in an ordinary eight-inch reflecting telescope, just as it would be if that telescope were directed at the sun out of doors; and since it is possible with any telescope to view the image not alone by looking into the eyepiece but also by projecting it on a screen at some distance from the eyepiece, the same is done at the planetarium. Here the distance is long, hence the image is very large—larger, in fact, than any solar image previously projected by similar methods. All this apparatus—the coelostat, fixed flats, and telescope—is entirely separate from the regular planetarium apparatus and could be similarly used with any ordinary house or building.



One of Deutsche Lufthansa's Diesel-engined mail planes for the North Atlantic service. Four 600-horsepower "Jumo" Diesels give it a speed of 186 miles per hour

DIESELS IN THE AIR

Prove Their Value . . . For Military and Commercial Operations . . . In Active Use . . . Nearest Approach to Smooth Turbine-Like Power Flow

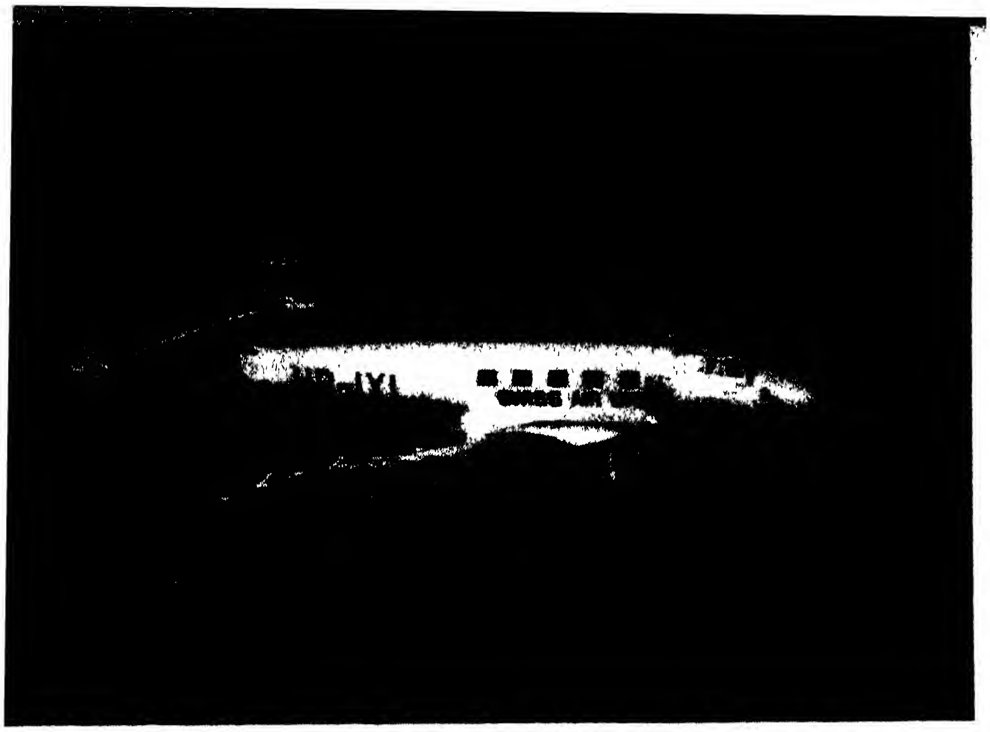
By **PAUL H. WILKINSON**
Author of "Diesel Aircraft Engines"

DRAWN up on the flying field, a squadron of Diesel-engined fighter-bombers stood ready to take off for maneuvers. As the engines were started up, the roar from 54 Diesels filled the air—high pitched and like a thousand racing cars in its intensity. At last, the order was given and flight after flight taxied to the starting line, throttles were opened wide and in a little over a minute, the squadron was in the air. As the planes climbed, their ranks closed in and the 27 fighting craft took up their battle formation. Once altitude was gained, they headed for their objective, soon to be joined by other squadrons of twin-engined bombers, Diesel-engined like themselves. With fighters above and on their flanks, and dive-bombers below, the air fleet rushed onward in impressive array. Fantastic? Not in the least. The year was 1937, and the planes were part of the regular equipment of the up-to-date German Air Corps, on their way to an air review at Nürnberg. But Diesel-engined planes? They were Junkers Ju 86 K fighter-bombers powered with Junkers "Jumo" 205 Diesels.

Following the lead of Germany, development of the airplane Diesel in other countries is now proceeding apace. In the United States, Pratt & Whitney and Wright, our two largest engine airplane builders, are understood to be busy on a confidential project for the Army and the Navy and, as their gasoline engines have now reached the 1500-horsepower stage, it is probable that a 2000-horsepower Diesel is their aim. Guiberson is working on experimental engines in the 300- to 500-horsepower class for the government, while some testing has been done with the 1200-horsepower Deschamps engine and there is the possibility that it may make its flight tests soon. Thus the United States, when the airplane Diesel "breaks" in this country, may be well to the fore with high-powered engines for military and commercial use.

In England, Imperial Airways and the Air Ministry are beginning to agitate for Diesels, and this type of power plant was made an issue in the recent debates. This should result in activity by Bristol and Napier, who already have had considerable experience in this field. On the Continent, the French government is sponsoring the 700-horsepower Clerget and the 600-horsepower Coatalen engines and, once they have proved themselves in the air, larger engines will be built. In Italy, Fiat and Piaggio are said to be much interested in the problem, while Japan has purchased a number of 600-horsepower Junkers Diesels with a view to manufacturing them in the Orient. Nor has Soviet Russia been idle, for already they have 700-horsepower Diesels in their helium-filled airships, which should result in adoption for heavier-than-air craft in due course.

DIESEL-ENGINED planes no longer are a novelty in Europe. A year ago, nearly 60,000 miles a week were being flown in regular airline service by these planes; since then, this mileage has increased enormously. Compare this with the total of 1634 miles flown in 1931, the first year of Diesel airplane operation! The most popular European plane in use is the Junkers Ju 86, the commercial version of the fighter-bomber. This is a twin-engined, ten-passenger airliner similar to the twin-engined Lockheed in the United States. Powered with two 600-horsepower Junkers "Jumo" 205-C Diesels, it has a top speed of nearly 200 miles per hour and cruises at about 175 miles per hour. The Ju 86 was the first plane to be specifically designed for Diesel operation, and is extensively used on the Deutsche Lufthansa airlines in Germany, and on connecting lines to the cities of Holland, Switzerland, Poland, and Denmark. Swissair



Swissair uses Diesel engines on its Zurich-Vienna route

uses this type of plane between Zurich and Vienna, and reports: "For your information we would like to state that for the second year we are flying a regular transport line with that type of machine. Last year it was the night mail from Basle to Frankfort, and this summer season the Junkers Ju 86 is in regular operation over the 370-mile direct route from Zurich to Vienna and back to Switzerland. The ship flies regularly 744 miles a day on that schedule. The policy of the company is to gain experience with Diesel engines as this type of powerplant is already a serious competitor for the ordinary gasoline engine."

LAST year a Ju 86 airliner, christened the *Lawrence Hargrave* after the famous Australian aviation pioneer, was flown from Germany to Australia by way of Rome, Tripoli, Cairo, Bagdad, Karachi, Calcutta, and Singapore. At the airports en route, it attracted the greatest interest, as it was the first time that a Diesel-engined plane had been seen in operation. At Rome, Signor Enrico Venturini, director of the famous Ala Littoria airline, exclaimed: "If heavy-oil engines were adopted on the Italian airlines today, instead of gasoline engines, on the mileage at present flown a saving of 10 million lira (about $525,000) could be realized." On another occasion, at the opening of the new airport at Stavangar on the west coast of Norway by His Majesty King Haakon VII, the Junkers company was invited to send over one of their Diesel-engined airliners. This they did, and the Ju 86 covered the 590 miles from the factory at a speed of 197 miles per hour. A careful check of the fuel consumed en route was made, and $14.80 was the cost! Worked out on a basis of a full complement of ten passengers in the plane, the fuel cost was $1.48 per passenger, or one fifth of a cent per passenger mile!

While the Diesel-engined Ju 86 is usually considered a passenger-carrying craft, it has also established an enviable reputation for itself in the field of private ownership. About a year ago, the *Kismet*, a privately owned plane equivalent to what we would call an "executive" plane in this country, achieved outstanding success in open competition in Egypt. It took first place in the international Oases Circuit Competition, organized as an annual sporting event by the Egyptian Aero Club of Cairo. The competition, which was a handicap affair, attracted a field of 41 entries from 11 different countries. Points were awarded for maximum speed and cruising speed, and low fuel consumption per passenger mile. The *Kismet* covered the circuit of 1300 miles, amid constantly changing climatic conditions and geographic difficulties, at an average speed of 180 miles per hour. Due to the fact that it had the lowest fuel consumption of any plane entered, it was not difficult for it to outclass its competitors.

After winning the Oases competition, Capt. von Sternburg decided to continue on to Afghanistan, along a route which some day may be used to connect Germany with the Far East. Flying by way of Bagdad and Teheran, he soon arrived at Kabul. There, a most disconcerting discovery awaited him—there was no Diesel fuel available for his plane. This did not discourage him, however, for did he not have a Diesel-engined plane with engines reputed to run on almost anything? Plenty of kerosene was to be had, so he tried it out and found that his engines ran satisfactorily. This solved his problem, so without further ado he tanked up the *Kismet* with kerosene and completed the next stage of his flight, 950 miles to Jask on the Persian Gulf, without the slightest difficulty.

Not only is the Diesel suitable for passenger work and for the private owner, but it is adaptable to airmail service as well. This was strikingly demonstrated when the Junkers Ju 86 mailplane *Buckeburg* and its crew of three made a non-stop flight from Dessau to Bathurst, on the west coast of Africa. During this 3600-mile flight, an average speed of 180 miles per hour was maintained. More remarkable still, when the plane landed it had sufficient fuel in its tanks for another 1400 miles, thanks to the extremely low fuel consumption of its engines. This flight has been made a number of times and on another occasion a distance of over 5000 miles was covered without a stop.

Bathurst, in British Gambia, is quite a center of Diesel aviation. It is from there that Deutsche Lufthansa catapults its Diesel-engined mailplanes for their 1900 mile hop across the South Atlantic to Natal, in Brazil. Dornier Do 18 flying boats, each powered with two Junkers "Jumo" 205 Diesels, make the crossing with clock-like regularity. Two of these planes are the *Aeolus* and the *Zephir* of North Atlantic fame, while they have as their teammates, the *Zyklon* and the *Pampero*. During the North Atlantic airmail survey flights of 1936, over 19,000 miles were flown by the *Aeolus* and the *Zephir* on their eight trips between New York and the Azores. On the 2400-mile direct route between these points, it was found that even these small flying boats could carry a payload of nearly 1000 pounds, due to the 25 percent saving in fuel weight made possible by the Diesel.

SO well pleased was Deutsche Lufthansa with the performance of its Diesel-engined planes in 1936, that it ordered two four-engined planes with similar power plants for its flights the following year. These powerful Hamburg Ha 139 seaplanes soon proved that they were equally reliable and much faster than their predecessors. Payload and accommodations for the crew left nothing to be desired. Catapulting was used for these 19-ton planes, with a catapult ship stationed at New York and another at the Azores. During the trials of 1937, the *Nordmeer* and her sister ship, the *Nordwind*, completed 14 trips across the North Atlantic, proving more conclusively than before, the advantages of the Diesel for long-distance flights across the ocean. These routine flights involved more than 33,000 miles of ocean flying over the direct route to the Azores, which was no mean achievement. During these trips, it was found that the fuel consumption of the Diesel was so low that a saving of more than 79 pounds of fuel per hour was possible for each engine, compared with gasoline operation. For a 16½-hour trip between New York and the Azores, this amounted to the astonishing total of more than 5200 pounds. Most of this saving in fuel

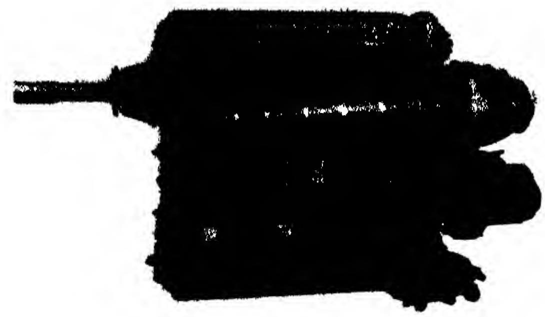
weight is available, of course, for additional payload, apart from the nominal load of 1000 to 1500 pounds which the plane is designed to carry. Airmail service between the United States and Europe was possible in 1936, but not advisable. In 1937, the Germans could have started regular airmail service but were denied permission to do so because the United States was not ready to compete with them.

In the meantime, while waiting to see what 1938 will bring forth, the Diesel has once again made history. Its most recent accomplishment, a non-stop flight from England to South America, was made with a view to breaking the world's long-distance record—and it succeeded. The plane was a Dornier Do 18 flying boat and its engines were Junkers "Jumo" 205 Diesels. The *D-ANHR*, as the German plane was marked, was catapulted from the Deutsche Lufthansa catapult ship *Schwabenland* off the coast of Devon, and 43 hours and 10 minutes later it glided down to a safe landing in the harbor of Caravellas, in Brazil. With Flight Commander von Engel in command, a direct route over the Canary Islands and the Cape Verde Islands was followed to Pernambuco, and thence down the coast toward Rio de Janeiro. North of the Equator, the winds were favorable, but subsequently head winds and storm areas developed. Although this prevented them from reaching Rio, they covered about 5200 miles, breaking the record of 4362 miles previously held by Italy for that type of ship.

Weight will always be an important factor in aviation. Fuel weight already presents quite a problem for the relatively small transatlantic passenger planes which soon will be in service. When 100-passenger airliners with 2000-horsepower engines are built, their fuel load will be enormous if gasoline engines are used. No one appreciates this fact more than the operators of such craft, but what can they do about it? Consider, for example, the Seversky design recently submitted to Pan American Airways in response to their call for aircraft in this category. Major de Seversky visualizes a "Super Clipper" that will fulfill the requirements with a payload of 43,000 pounds, and a cruising range of 5000 miles at a speed of 250 miles per hour. For power plants, he specifies—for want of anything better—eight gasoline engines of 2000 horsepower each, with 2300 horsepower available for take-off. Assuming that the engines cruise at 70 percent power output, then 11,200 horsepower would be used continuously in flight. Assuming, again, that their fuel consumption is 0.45 pounds per horsepower per hour, then 5040 pounds of gasoline would be used each hour, or 100,800 pounds of gasoline for the flight of 5000 miles called for in the specifications.

Now let us consider the matter from the Diesel standpoint. If Diesel engines of equal power were available, their fuel consumption certainly would not exceed 0.36 pounds per horsepower per hour, and might well be 0.34 pounds under average operating conditions. Taking the higher figure to be conservative, this works out at 4032 pounds of fuel per hour, or 80,640 pounds for the entire journey. In other words, there would be a saving of 20,160 pounds, or more than 10 tons, in the weight of fuel that the plane would have to carry. But this is not all. When fuel loads of this magnitude are concerned, there is also the cost factor to be taken into account. Aviation gasoline costs 11 cents a gallon at refinery, compared with 5 cents a gallon for furnace oil suitable for aircraft Diesel use. To this must be added, in each case, approximately 5 cents for taxes and 2 cents for transportation. Thus the cost for 16,800 gallons of 87 octane gasoline would be $3024, compared with $1382 for the 11,520 gallons of Diesel fuel needed for the trip. These figures, of course, do not take into account the appreciable quantities of much more expensive 100 octane gasoline which are required for the take-off of the gasoline-engined plane. Savings such as these, of 20 percent in fuel weight and 54 percent in fuel cost, certainly are factors of importance to any airline, apart from their advantages for other users, commercial and military alike.

NEXT year, or the year after, may see the advent of the 2000-horsepower Diesel in huge airliners for flights across the ocean. Based on their highly successful "Jumo" 205, Junkers already has its 1200-horsepower "Jumo" 206 on test. Following this will come their 2000-horsepower engine, now under construction and to be completed by the end of 1938. So compact will this 24-cylinder "square" engine be, that its diameter will be only 39 inches. So well-designed will it be that its fuel consumption will not exceed 0.34 pounds per horsepower per hour. As for its weight, it is claimed that this will be little more than one pound per horsepower, due to the compactness of its design. Operating on the two-cycle principle like its predecessors, at 3000 revolutions per minute it will have 144,000 power impulses per minute from its 48 pistons—the nearest yet to the smooth operation of the turbine so sought after for an engine in the air.



Left: A Junkers "Jumo" 205 Diesel with a new two-speed exhaust-driven supercharger

Below: The record-breaking Dornier Do 18 flying boat, "D-ANHR," which holds the world's long-distance record for seaplanes. See the text

SLICING and POLISHING METEORITES

By ALBERT G. INGALLS

Marking the cut to be made

THE instant a meteor hits the ground it automatically becomes a meteorite, but the two terms are merely matters of arbitrary definition. While a majority of meteorites are mainly or almost entirely of stone, a majority of those which have been found are mainly of iron. This apparent contradiction is explainable by the fact that iron meteorites are sufficiently peculiar in appearance to be noticed, while one not well versed in mineralogy might easily pick up a stone meteorite that until the day before had been wandering alone in open space for millions of years and heave it at a too-musical back yard fence cat without knowing it wasn't a common stone.

Among the larger meteorites in museum collections is one that fell at Paragould, Arkansas, in 1930. It is now displayed at the Field Museum of Natural History, Chicago, is of the stony type and weighs 750 pounds. It was actually seen to fall and was later traced down and found, and with it were some "younger brothers"—smaller meteorites that had been coasting along through space close to it, like a covey of ducks. One of these little brothers was sent to Washington, D. C., and subjected to dissection, in order that slices of it might be sent to different institutions, there to display the internal structure. The four photographs reproduced on the present page show it at four different stages in the process of preparation. The meteorite surgeon doing the work is Mr. B. O. Reberholt, an expert connected with the Department of Geology at the United States Museum.

THE slicing is done by means of a toothless saw—a plain, smooth band of metal driven by a band saw, but there are "teeth" in this saw, after all, for these consist of loose grains of abrasive which are fed in and then pressed and rubbed against the meteorite by the metal band which is kept in continuous motion. In the first photograph (upper left) Mr. Reberholt is shown marking out the cuts to be made. In the upper right-hand picture the saw is nearly through a cut. In the third (lower left) the cut is complete and the slice is being examined, while in the lower right-hand photograph the slice lies on a flat table and is being polished.

The driven band or stone saw has a velocity of about 950 feet per minute—found to be the best speed. Carborundum grains (No. 100—about the size of grains of table salt) are fed into the cut from a small trough, by means of a trickle of water, and they drop into a kind of cup made by surrounding the top of the cut with molding clay. This directs them to the point where they will do the most good as the band moves downward through the meteorite. It all looks quite simple but anyone who has used a metal band with abrasive grains to cut stone will agree with a statement that Mr. Reberholt recently made in *Rocks and Minerals:* "There is a lot to learn about cutting minerals with a band saw." To complete a slice like that shown requires about two days' work. The meteorite cannot be hurried or crowded too rapidly into the saw, else the cut will not be straight.

Nearing the end of the cut

After a perfectly straight cut has been made the slice thus obtained is fine-ground and polished. The grinding tool, shown in the lower right-hand photograph, is a flat, horizontal piece of cast iron mounted on a vertical spindle rotating at 150 revolutions per minute and attached to the end of a movable pantograph arm. Thus the tool can be zigzagged over the specimen. Carborundum grains in sizes 100, F, and 600 are successively used, each with a fresh cast-iron tool, the last-named abrasive having the general fineness of flour. The fine-ground surface is next polished on a convex felt buffer armed with No. 600 Carborundum and the specimen is ready for public display.

Examining the detached slice

Polishing the slice with power

OUR POINT OF VIEW

Steam and Wings

FOR several years, preparations have gone forward with deliberate haste looking toward the establishment of transatlantic airplane service. Expectations were that this summer would see the beginning of scheduled flights. Such a brilliant consummation of well-laid plans would have been something more than epochal, for this year is something more than normal in transportation; it is an important anniversary.

Just 100 years ago last April, two ships steamed into New York harbor a few hours apart. Mind you, they *steamed*. When the *Sirius*, from Cork, arrived in the harbor, she was not the first steam-propelled vessel to cross the Atlantic, but her arrival marked the beginning of regularly scheduled crossings. She made the trip in 19 days. When the *Great Western*, from Bristol, arrived a few hours later after a trip of 15 days, she had started a schedule of steamer travel that was later interrupted for only one short interval and had a speed record that stood unbeaten for years. The *Sirius* was scarcely larger than a modern tug and had been built for channel service, while the *Great Western* had been constructed specifically for transatlantic service; and on their first trips, neither knew that the other was on the way.

The Atlantic has been crossed by airplanes a number of times in single flights. The parallel between the beginning of steamer services and the coming airplane services stops about there. We do things differently now, have made great advances. No surprising, unheralded landing will announce the completion of the first flight of a new transatlantic air service. Radios, cables will tell of the take-off, give minute-by-minute details of the flight, flash news of the safe landing to all the world. The chances are that there will be several simultaneous flights, for it is no longer possible to get the jump on the other fellow; nations have been jockeying for top position where they can get sizable slices of the forthcoming passenger business, seeking landing privileges and entering into all sorts of reciprocal agreements. Then, too, the planes will have been built specifically for the service, and will have embodied in their design and operating features a wealth of experience gained from thousands of miles of long-distance, over-water flight.

Steamship services across the Atlantic marked the beginning of an era of speed in transportation reaching forward to the present day. The airplane has already vastly changed our mode of thinking; what will it do when it starts winging its way regularly back and forth across the north Atlantic?—*O. D. M.*

Toll

BACKED by a desire for private gain—a desirable feature in itself—come occasional proposals to build toll roads in various parts of the country. Hopefully, plans are offered that supposedly will give the motorist better and safer roads, opportunities for greater sustained speeds, freedom from congestion, and so on. The history of toll roads in the horse-and-buggy days need not be taken as the only basis upon which to predict ultimate failure of such schemes. In present-day Italy are about 300 miles of modern motor highways built originally as toll roads. Anticipated income failed to materialize; the government has taken over the roads and opened them, free of charge, to the public.

That tolls are necessary in certain cases—bridges and tunnels, for example—cannot be denied, but highways built by private companies are quite another matter. It is a foregone conclusion that a large proportion of the traffic that could use such roads would seek other and free ways of reaching destinations. Private toll roads to remote or spectacularly scenic spots are now in successful operation; these again are not to be compared with inter-city or transcontinental pay-as-you-go highways.

There is another angle to this situation: Human beings are naturally reluctant to pay a second time for something that should be theirs by right of previous payment. The motorist pays enough taxes on his vehicle, the fuel that makes it run, and the oil which keeps it running, to be provided with ample highways along which he may travel without having to pay another cent in tolls. His toll has been paid. He pays more of it every time he buys a gallon of gasoline or a quart of oil. But the pennies he contributes to the tax fund all too often do not go to the construction of new roads, the repair of old roads, or even to new signs to keep him in the right direction. Schools and sewer systems, municipal and state "improvements," eat into the funds, diverting money that was collected for specified purposes to other uses which rightfully should draw their costs from taxation levied on all citizens rather than on a segregated group.

If motorists' taxes are applied to facilities that benefit the motorist directly, and tax diversion is summarily stopped, motor-car drivers will have all the highways they can possibly use, safety will be increased, congestion will decrease, and toll-road ideas will once more be relegated to the files.—*A. P. P.*

Sedatives or Hypnotics?

"MY doctor prescribed them for me, said that they are non-habit-forming. They just calm the nerves and you go right off to sleep." So often is this statement made in this country today, that it might well have been promulgated, word for word, as an advertising slogan by the manufacturers of barbituric acid derivatives. Insomnia and this word-of-mouth advertising have so lowered the common-sense level of the American people that the sale of these synthetic "sedatives" has grown to enormous proportions. A doctor recently told us: "Their widespread use is the greatest disaster that has befallen the people in years."

The depressions, labor troubles, bewildering national policies, and the piling up of taxes have given us all cause for sleeplessness. Hence any suggestion that we must achieve an ascetic calm would be but an inanity. Yet a steadily growing dependence upon drugs which are called "sedatives" but are in reality "hypnotics," which are called "non-habit-forming" yet are cumulative poisons—a dependence upon these is bound to total up to much human misery and, in some cases, death. This is the essential argument in a long article in *Hygeia*. Some of the barbiturates "are blessings when given to the right person in the right dosage under the observation of a physician," says the article. "But there is none which is safe for Mr. Average Man to use at his own whim."

Some of the barbiturates "accumulate in the system until the organism becomes acutely poisoned"; prolonged use of most of them injures the nerve tissues irreparably; all are dangerous in some degree and have carried many people to hospitals, insane asylums, and to the grave.

The author of the *Hygeia* article makes a strong plea for a federal law to prevent promiscuous sale of these deadly drugs—a law far more stringent than that of New York City where, if the druggist knows you, the barbiturates may easily be purchased without a prescription. Before such a law is passed, however, consult your doctor or the American Medical Association before you take the advice of some well-meaning friend to "calm your nerves and sleep" with a barbiturate.—*F. D. M.*

Boards From Fiber

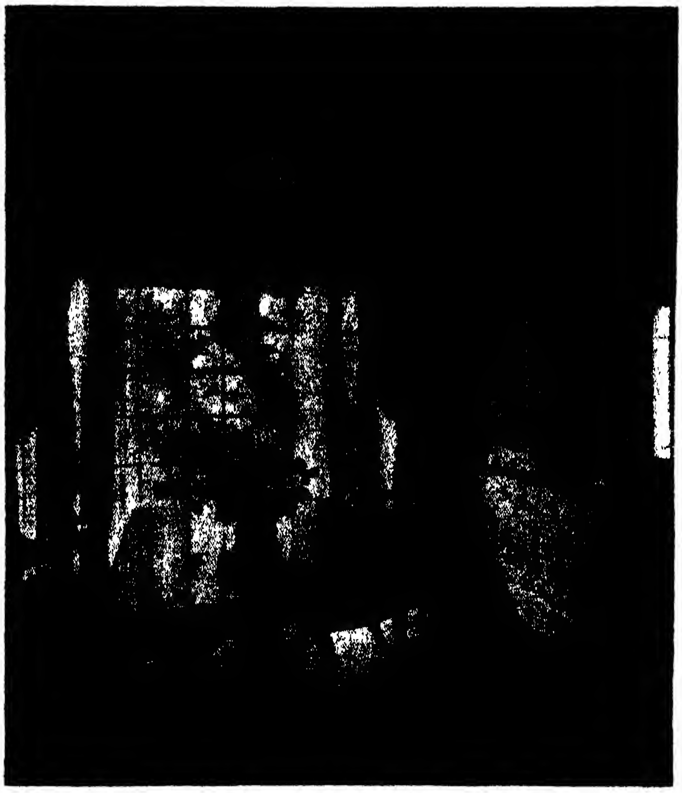
Composition Boards Originated as Wall Coverings . . . Now Find Wide Use . . . Field of Use Constantly Widens . . . Manufacture . . . Research for Future

By PHILIP H. SMITH

FIBER boards, which began commercial life strictly as a wall covering, now enter into the manufacture of railroad coaches and trailers, motor vehicles and toys, signs and marine partitions, and hundreds of other unrelated products.

Here is a new material rather than a substitute. Millions of square feet of it are produced annually to satisfy demands that its originators never foresaw. It has been given qualities in a wide variety of combinations to serve specific purposes. Strength, resistance to moisture and to fire, insulating and acoustical properties, have been built-in to banish forever the idea that commercial board is merely a substitute for wood.

Pioneer producers of fiber-board were concerned mainly with two objectives—to manufacture a building material having a large unit area which would reduce handling and installation costs, and to utilize waste products in the making. Use in the hands of the public soon revealed that close control over every step of the manufacturing process must be exercised to obtain a uniform product, and as that control was attained, development came rapidly.



Boards of various fibers are used in many places in homes such as this—from rough cellar partitions to fine panelling

The basic material of composition board is a fiber. The fiber may be derived from wood or other vegetable growth. Wood and paper pulps are used, while, to a lesser extent, fibers are obtained from wheat straw, cornstalks, flax, and licorice root. Some types of boards combine ground-wood with sulfite; others are made wholly from waste paper and there is a very heavy production of board made from exploded wood chips, and from bagasse, which is the cane fiber from sugar mills. Whatever the fiber used, it is the manipulation and combinations of ingredients which impart specific values to the board.

Most fiber boards are made on a modified paper-making machine; that is, the fibers are treated by a mechanical or chemical action in a pulping process and are then mixed with many times their volume of water and flowed out upon a screen so that the fibers fall into a mat as do the fibers in felt; hence this is called "felting." The bulk of the water is extracted by pressure and heat to leave a thick mat of interlaced fibers, ready for pressing to a desired thickness and density. A four-inch mat of fibers, for example, may be pressed to a half inch thickness to make a hard-finished board.

Laminated boards differ from the homogeneous board in that they are built up from several layers to impart strength. The requisite number of plies of fiber stock are fed continuously from rolls into a laminating machine. Each ply is given a coat of adhesive before all are brought together at a central point. After lamination, there comes a pressing process and then kiln drying to remove excessive moisture. Various adhesives are used, most of them secret in formula, but minerals, asphalt, mastic, and casein are known to be employed.

In the course of research and development it was discovered that the length of the fibers and their positioning had much to do with the ultimate strength of the board. This explains, for example, why ground-wood with its long fibers makes a product of high quality.

WHEN wall board first came into use, troubles were experienced with expansion and contraction. An excess of moisture would cause the board to buckle, while a dry atmosphere would produce cracks or cause the panels to pull away from each other. A great deal of research has been devoted to the problem of overcoming this affinity for water vapor, and a reasonable amount of success has been obtained. Practices are either to attempt to seal each fiber or to coat the entire board to exclude moisture. Some producers employ a rosin size in accordance with paper-making practice; one manufacturer uses petrolatum. Whatever the process employed, the net effect has been to reduce expansion and contraction movement to a point below that of ordinary wood.

When a board is to be used for exterior construction, more serious attention must be given to water-proofing. In certain cases, water-proofing compounds are added to the beaters while the fibers are being separated so that each fiber will be coated. Another practice calls for impregnating the board after forming, using a vacuum process. Several producers coat the board with asphaltum to make it serve for sheathing.

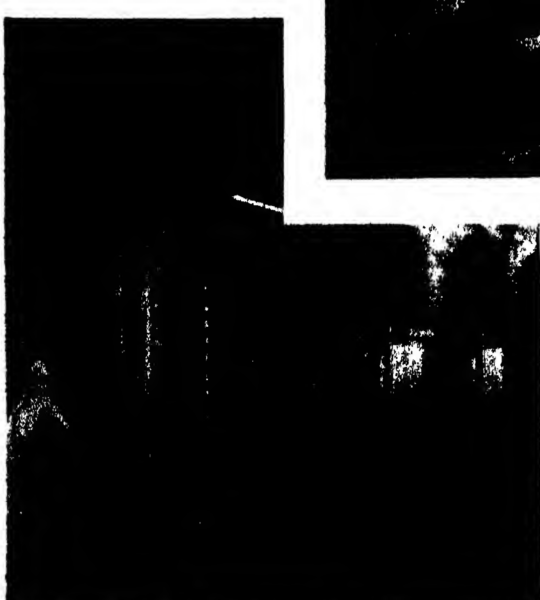
The manufacturers of board will not declare the problem of water vapor completely solved until they are able to pro-

duce an inert product. This they strive for because it would broaden the utility of the product. As it is, boards which are treated with various oils are now used for flooring and for concrete forms. Rosin and alum water-proofed boards are used for sheathing with an extra surface water-proofing coat. One product, made wholly from newspapers and water-proofed in the manufacturing process, is employed widely for chicken houses, tourist cabins, and other small structures.

AMONG the many fibers used for insulation board, bagasse (sugar cane after extraction of the juice) plays a prominent rôle. The fiber has the merits of being long, tough, springy; its serrated saw-tooth surface facilitates proper felting. Following a long and detailed preparation, the fibers are mixed with filler fiber and with rosin and alum water-proofing to exact proportions. Then, just before the mixture goes to the board machines, chemicals are added to it to coat each fiber and render them resistant to dry rot and termites.

To felt the bagasse fibers into board requires the addition of great quantities of water. A mixture of one pound of fiber to 199 pounds of water enters the forming end of the board machine which produces the wet board; at the other end emerges a product consisting of water and fiber in equal parts. The form is now that of board and runs continuously into a drier which removes the remaining moisture and permits the board to shrink and set to permanent form. The final step in the process is to cut to size, bevel, groove, or drill as the need may be, and allow seasoning and humidifying to bring the moisture content up to atmospheric conditions.

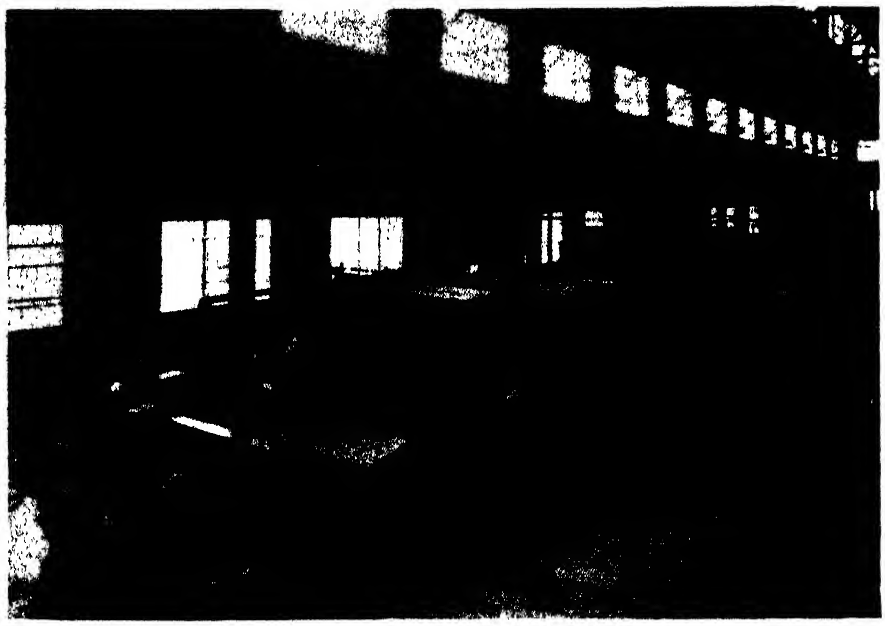
Inspection of board products on the market reveals little of the care and control in manufacture necessary to produce uniformity and specific qualities. The above-mentioned bagasse board, for example, comprises primary fibers which interlace to form the framework, and secondary, or shorter fibers, which give rigidity. Then the spaces between fibers are filled with light cellular particles or pith to increase insulating value. Finally, there are extremely fine fibers to hold the pith and other fibers in place. All these constituents must be used in exact proportions.



At the top is shown the "gun" used for exploding wood chips. The resulting product is a mass of fibers which are then treated, mixed with water, and carried to a forming machine. The center picture shows a thick blanket of fibers known as the wet-lap. The presses at left squeeze out the water from the matted fibers and form the board under sustained pressure

Quite distinct from board manufactured along paper-making lines is one made from wood fiber produced by an explosive process. Saw-mill chips and waste pieces of wood are fed into a 20-inch caliber "gun" which is then closed. Steam is introduced for about one minute until the pressure reaches 500 pounds. Then the pressure is raised quickly to 1000 pounds, held there for a few seconds, and, finally, the bottom valve of the gun is opened to release the wood and steam simultaneously. This sudden discharge causes the wood to explode into fibers.

When the fibers are thus separated, they are mixed with water in the ratio



In many respects similar to a paper-making machine, the board machine subjects a wet mat of fibers to both heat and roller pressure to make finished boards

of one to 50, pumped through refiners, and carried to a forming machine. As the fiber-water mixture is run over the machine, water is gradually withdrawn by vacuum and pressure rolls, to leave a thick blanket of interlaced fibers. This is known as "wet lap." The next step is to trim the wet lap to size and run it through presses by means of a wire screen which permits escape of the steam generated in the drying. The length of time the mat stays in the presses, and the pressure used, determine the thickness and density of the product. The binding compound in this instance is the natural lignin of the wood and, when pressures of 1000 tons are applied, it is quite adequate to produce a hard, durable board.

WHEN commercial production of this type of board was first undertaken, it was believed that adequate raw-material supplies could be had from edgings, slabs, and short lengths which were the waste of saw mills. It was an underestimate, for today thousands of cords of second-growth pines and hardwoods are required to feed the factory. The machine which forms the wet lap produces at the rate of more than 100 feet a minute and has an insatiable appetite.

The advent of the homogeneous board —that is, non-laminated—opened the way to the production of insulating board. It was realized that if fibers could be matted together and subjected to light pressure, the air cells remaining, plus the cellular form of the fibers themselves, would give insulating properties. Today, a very large percentage of all board manufactured is used for insulating purposes. It is used for interior wall covering without further treatment, or it acts as a plaster base. When used as a sheathing board where there is chance of exposure to weather, it is usually given a protective coating. One widely used board is covered with asphaltum on one side and an aluminum compound on the other.

Closely allied to the insulating boards are the acoustical products. They are too varied in nature to be described in detail here. It is enough to say that they are engineered to absorb sound and are used successfully in public auditoriums, offices, and in truck and bus manufacture where sound-deadening qualities are desired.

In recent years, board has undergone what might be called "style change" which has widened the field of use even more. Perhaps the first step in this direction came when manufacturers learned the trick of beveling panel edges to obviate the use of mouldings to conceal joints between panels. This drove home the idea that boards might be pleasing as well as practical. A subsequent development was to impart a wood grain by casting in molds and then painting in appropriate wood colors. This board is water-proofed and can be used for exteriors as well as interiors where a panelled wood effect is desired. Several manufacturers offer boards to which are bonded rare and costly woods as well as common woods in veneers. A thickness of 80-thousandths of an inch is enough to give a board veneer which is practical for most purposes.

The idea that board might be used as a base, with other materials bonded to it, opened up quite a field for development. Board is now made with a surface covering of a plastic to achieve a lower cost panel than can be had with an all-plastic product, and a more durable surface than ordinary board offers. Panels of this type are to be found in the baths on the *Queen Mary*. More recently there appeared on the market a product which is not called a fiber board, but can properly be mentioned to show this newer development. Sheets of stainless steel, either 0.008 inch or 0.015 inch thick, are bonded to a water-proof, flexible board by a heat and pressure process. They are suitable for wall coverings. When produced in tile size, they are used to line the walls of baths and kitchens, and when bonded to a thick board they are intended to serve as partitions in ocean liners where low maintenance cost and high fire resistance are desirable. The stainless steel retains its polish.

Regardless of the many qualities which have been built into boards, the original attribute of having large surface area is still predominant. It is this quality, accentuated by improvements, which made the board suitable for trailer construction. An entire side wall could be made of a single piece of board where the only opening was that for windows. Large area and good surface qualities have introduced the boards to mural work as a substitute for canvas. Millions of square feet went into such projects at the Century of Progress Exposition, the Texas Centennial, and the Great Lakes Exposition. Large surface area, light weight, and the capacity for being bent to form have made board suitable for the interior roof construction of railroad coaches. Even passenger automobiles use this board widely. Prior to 1927, many manufacturers employed it for roof construction, but it was outmoded by wire and fabric and later by steel tops. Today it serves as an insulator against heat transfer from motor to driver compartments.

THE possibilities in board development are by no means exhausted. With a firm hold on the market for interior building construction, it now moves steadily toward adoption as a material for exteriors. As fast as the means are found for imparting weather-proofing qualities, its use broadens. We can look for more durable products as the outcome of laboratory research and for many more types of boards bonded to other materials. Experiments are now being conducted with synthetic resins to serve as binders and to impart greater moisture-resistant properties.

Standing in the way of progress has been the near-dormant state of building construction. But if a building boom should get under way, manufacturers would acquire a volume of orders that would permit more experimentation. As it is, the lapse of construction has not been a total loss; it has greatly stimulated the cultivation of new uses and has provided time in which to lay a strong foundation for future conquests.

Photographs courtesy The Masonite Corporation and The Upson Company.

PLANTING FOR ECONOMY

Wider Spacing of Trees . . . Lower Costs . . . Weeds, Bushes Enrich Soil, Cause Branches to Rot and Drop Off...Pruning Unnecessary...Quality Lumber

By CLYDE MITCHELL

BETTER lumber can be grown and the speed of production can be accelerated, thanks to research, but until recently most planting methods overlooked means whereby soil fertility could be maintained for successive tree crops.

Now from Swann Forest, a state conservation enterprise in southwestern Massachusetts, comes a method of planting which assures soil upbuilding along with quality lumber, and also permits great economies in tree growing.

The new "skeleton" planting calls for setting out only as many trees as are needed for the ultimate stand. Thus, at the outset, 75 percent of tree and planting costs are eliminated, because hitherto a 1200-tree planting has been made for a 300-tree, single acre forest.

In the older method, where plantings were made six feet apart each way, the excess of trees allowed for expected losses; side crowding forced long, straight, knot-free growth, while shade checked "weed" growth. None of these advantages have been lost in the new method. Seedlings which fail to survive can be replaced, while "weed" growth, or deciduous bushes, do the crowding. But there is this added advantage; the weeds keep the air moist so that dead branches rot and fall off, thus eliminating the trouble and expense of pruning.

Skeleton planting bases on more than 17 years of experimentation with plantings and observations of the natural. One of the earliest discoveries was that old fields pass through a definite, but not clearly marked, plant succession by which soil improvement takes place. Before any natural planting occurs on impoverished soil, there must be vegetative changes or successions to restore productivity. These successions were found to be grass, then herbaceous growth, after that low-bush, high-bush and finally saplings, which formed the start of the natural forest. Sometimes the stages overlap; sometimes one appears to be skipped, but the progressions are always similar.

These plant successions were found to help reduce soil acidity and to protect the soil with moisture and shade while allowing the sun and air to reach it. When they died they gave back organic material and bettered conditions for the growth of soil bacteria and for nitrification.

OUT of the experiments leading to the development of skeleton planting came several new principles which are a part and parcel of it and these can be stated in equally direct and simple terms. Here are some of them:

Never plant land until the soil has recovered. The appearance of volunteer vegetation will herald the proper time. Any attempt to accelerate the process merely results in a waste of time and energy. Furthermore, trees planted too soon will lack vitality and be more susceptible to attack by insects and disease; soil will be unduly depleted and the quality of the ultimate stand of trees will be impaired.

Plant trees at 12-foot intervals and permit brush to grow up around them. The only necessity for pruning arises when the brush grows too fast and closes over the stand of trees so that sun and air are shut off. Any hardwoods pruned out of a conifer stand for this reason should be scattered on the ground to decay within the forest borders. It does not make for neatness, but neatness can be had only at the expense of fertility.

It is unwise to plant more than one-quarter acre of land solid to any single species of conifer or hardwood. Extensive plantings of a single species encourage the spread of disease and pests, but, even more important, conifer plantings should always be under the influence of neighboring hardwoods. When both conifers and hardwoods grow in close association, the health of the soil is improved and we then get, in reality, a crop rotation under a continuous crown cover.

When these principles are followed in conjunction with skeleton planting the following advantages have been found to accrue:

Vegetative cycle and soil recovery can progress undisturbed. Root competition is nil at the outset, permitting maximum vigor and growth per tree. Thinning is eliminated. Pests and disease are diminished. Management operation is simplified.

While Swann Forest researches are aimed to solve the timber problems of Massachusetts, their findings are applicable to all of New England and to a very large extent to land and forest problems throughout the nation. New England is not alone in having millions of acres rendered incapable of supporting quality timber growth and the first step in doing something to arrest the spread of this disaster is to understand what to do.

A future forest of white pine. The trees are set wide apart, and brush and weeds fill the remaining spaces. The rank growth will die down and improve the soil

HOW HOT IS THE SUN?

It Has No Single Temperature but the Layer that Sends Us its Light Directly Averages About 5740 Degrees, Absolute, or 9873 Degrees, Fahrenheit

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THIS title may suggest sweltering dog-days; but, if anything could make these seem cool by comparison, it would be the answer to the question.

It has been realized for a century or so that the sun, even on its visible surface, was hotter than anything that man's devices could produce. When the sun's rays are concentrated by a lens of short focus, or, better, by a large mirror, which does not waste heat in transmission through thick glass, the image is not merely dazzlingly bright; it will melt the most refractory metals. A more far-reaching test is found by comparing the surface brightness of the sun with terrestrial sources. A candle flame, or an old fashioned oil-lamp, is not very hot, and shines moderately—one can look straight at the flame and not feel dazzled. The tungsten filament in an ordinary electric light is far hotter; it is dazzlingly bright, and would still appear so if placed in front of a candle flame as background. But this filament, in full glow, would look black against the sun—if we set it up in broad daylight, and looked through a heavy shade-glass to protect our eyes—and if we had one of the old-style clear glass bulbs that are now out of fashion.

But this only shows that the sun is very hot, and does not tell us how hot it is. We must think a bit before we can be sure that the last question has a meaning or how its meaning is to be defined.

The sun is a sphere of gas, with no sharp boundary. Its edge looks sharp to us because it is so far off that a transition layer of gradually thinning atmosphere, a hundred miles deep, would be practically indistinguishable except with a great telescope, and air steadier than there is much hope of finding.

If the sun's atmosphere were as clear as the earth's is at its best, some diffuseness at the edge might nevertheless be observable; but it is full of electrons and other charged particles, and well-tested theory shows that such a gas would scatter light like a thin haze. The greater the pressure, deeper in the atmosphere, the hazier it will be.

This is why the details of sun-spots, and the like, look sharp in the telescope. There is nothing solid there, nothing liquid, nothing even as substantial as a thin summer cloud, with its tiny scattered drops of water—only gas which is hotter in some places than in others. But, since this gas is full of electron-haze, we cannot see deep into the sun—probably only a hundred miles or so below the level where the haze really begins. Underneath this level there are, in all probability, tremendous tornadoes in the solar gases, where in some places expansion cools them. But we cannot see down into these. The haze shuts off our view. But it does not, and cannot, prevent a greater amount of radiation from escaping upward where the deeper layers are hot than where they are cooler—and so we have the visible spots.

IN such an atmosphere, through which a great flood of energy is escaping upward into space from the deep interior, there must be a temperature-gradient. The lower layers must be hotter than the upper to keep the heat flowing. The light that we see does not come from any one layer. Part of it comes from deep, hot layers, but has been much enfeebled in getting through the haze above them. Part of it comes from upper, cooler layers, which we see almost unobstructed, but which are almost transparent, and so send out little light. When this is realized we can understand why that great solar physicist of an earlier day, C. A. Young, said: "It is only by courtesy that the sun can be said to have a temperature." However we make our observations, we have to deal with a complex mixture of influences from different layers, of different temperatures.

Obviously the best we can hope is to get some sort of average, but even this is hard, for we cannot find, directly, the temperatures of the hotter and cooler layers, which we have to average. We are therefore led to the invention of an "effective temperature." This is the temperature which a body of standard radiating properties must have, if its radiation is to be like the sun's when compared in some specified manner.

There are many different ways of making our specifications and, naturally enough, they lead to different results. The simplest is to specify that our standard radiator shall be as big as the sun, and send out the same total amount of energy—or, alternatively, that it shall send out the same total amount of energy per square centimeter of surface.

For a perfect radiator, or "black body,"[1] this amount is proportional to the fourth power of the absolute temperature (measured from absolute zero). The radiation at a temperature of 1000 or 2000 degrees can be measured in the laboratory. The radiation which we get from the sun can also be measured, and a simple computation makes the sun's effective temperature 5740 degrees K (on the centigrade scale, from absolute zero). The uncertainty of this figure is perhaps 1 percent—arising mainly from the difficulty of allowing precisely for the absorption of the sun's radiation in the earth's atmosphere before we can measure it.

This is far hotter than any terrestrial furnace—naturally, because it is far above the boiling-point of any known substance. The incandescent gases in some electric arc discharges are about as hot, but too thin to send out very much light. Higher temperatures have been reached by "exploding" thin metallic wires by the passage of a very heavy condenser-discharge; but, within a few millionths of a second, the gases expand and cool.

This value of 5740 degrees (absolute, or K) is doubtless the best one to remember, if we wish to speak of the sun's temperature. It is practically certain that this temperature is reached somewhere in the middle of the layers from which light reaches us directly; the deeper layers, almost obscured by haze, are hotter, and the outer ones cooler.

But we may set up our specifications in other ways. For example, we may seek the temperature of a black body which would give out, per square centimeter,

[1]It has this strange name because a perfect radiator would also be a perfect absorber of radiation, and, if cold, would reflect no light at all, and be perfectly black.

the same amount of light of one given color (or wavelength) as the sun does. Calculations on this basis are easy enough to make, and the sun's radiation in different wavelengths has been pretty well measured; but the results range from 6300 to 5600 degrees, according to the wavelength taken for study.

This is not surprising. The opacity of the sun's atmosphere need not be the same for light of all kinds. With a wavelength to which it was more transparent than the average, we would see deeper, and get light from hotter layers, and more of it, and the reverse is obviously true. The differences are not alarmingly great; indeed, the theorists have rather a hard job explaining why they are not greater.

If we take our sample area of the sun to represent, not the average for the whole as we see it, but the measured values for a small portion of the center of the visible disk, we find higher temperatures—for example, about 6300 degrees from the total radiation, while, if we measure an equal apparent area close to the sun's limb, we get only 5000 degrees. This is again easily intelligible. When we observe the center of the disk, we are looking straight down into the haze and so see as deep as possible. Toward the limb, our line of sight strikes the sun's surface at an increasing slant, and the same number of miles of path in the haze take us to a smaller depth, and so to cooler gases. Both 6300 and 5000 are good and reliable average values, under the circumstances of the special observations, for the layers from which the light actually comes. The value 5740 degrees is a sort of general mean for all angles of observation—or of emission of the sun's light.

BUT, we may ask instead: How hot must our standard body be if it is to give out light of the same color as the sun? This is too vaguely stated; to be precise, we should demand that the relative intensity of the radiation of two specified wavelengths—say in the yellow and the violet—should match the observations of the sun.

"Color-temperatures" of this sort have the great practical advantage that they can be made just as well on a distant star as on the sun, for, in empty space, the color of the light is not altered as it travels. (In some cases there is evidence that the space between us and the star is not perfectly clear; but we need not bother with this now.) But they have two disadvantages. First, their evaluation demands high accuracy of measurement. This is not very bad, as good measures of the kind required can fairly easily be made. Second, and much more serious, are the difficulties which arise if the atmosphere of the star (or of the sun) is not equally opaque for all wavelengths. Suppose, for example, that we are comparing yellow and violet light. If the haziness and opacity of the gases affect the two to the same extent, we will "see down" to the same depth with both, and the light we observe will come from substantially the same layers. Under these circumstances, it is found that the color is nearly—though not exactly—the same as would come from a black body giving out the same total radiation, so that the "color-temperature" and the other effective temperature are nearly the same. But, if the atmosphere is considerably more transparent in the yellow than in the violet, the yellow light will


Sunspots photographed with a 12-inch reflector, by L. and H. Cox, Mitcham, County Surrey, England

come from deeper and hotter layers, and be stronger in proportion than the violet light. More yellow light corresponds to a lower temperature; so the color-temperature will be low. Conversely, if the atmosphere is more transparent for violet light, the color-temperature will come out high.

This actually happens for the A-stars (of which Vega is a type). Careful measures at Greenwich have shown that the average color of these stars corresponds to a temperature of about 16,000 degrees—while the degree of ionization of the metals, revealed by the spectrum, shows that it cannot be higher than 12,000 degrees and is probably lower. There is good reason to believe that the opacity of the atmospheres of these stars is mainly due to hydrogen, and is much greater in the red than in the violet. We should therefore expect the color-temperature to come out too high.

Finally, there is still another way in which we may define the effective temperature—the "excitation temperature." The lines of a rich spectrum, such as that of iron or titanium, are not all absorbed by atoms in the same state. Some are produced by atoms in the normal state—to which they automatically revert if left alone long enough—and others by atoms in "excited" states, loaded up with considerable amounts of energy. Most of the atoms are always in the normal state. The proportion which are in the excited states should increase rapidly with the temperature.

By measuring the strength of lines in the solar spectrum, and comparing the results with the strength observed in the laboratory under known conditions, it is possible to find the relative numbers of atoms—say of iron—which are in the ground state and various excited states, and hence to calculate the temperature which would be required to produce these results.

Two independent investigators have lately applied this method to the sun—R. B. King, working on lines of titanium, and Menzel, Baker, and Goldberg with iron and titanium. They agree in finding a very much lower temperature than any of these already mentioned—King obtaining 4400 degrees, and Menzel and his associates 4350 degrees from titanium and 4150 degrees from iron. The last named result depends on intensities calculated from a theory which is admittedly too simple for the complicated spectrum of iron, but the general agreement of all the results is impressive.

AT first, it looks as if something was very wrong indeed; but, when one looks into the theory one finds that, under such conditions as prevail in the sun's atmosphere, the atoms are got into, and kept into, the excited states mainly by the absorption of light in their own spectral lines. The degree of excitation should therefore depend mainly on the amount of light available for the atom to absorb. Now the region in which the observed lines are produced is pretty well up in the sun's atmosphere. Could we strip it off entirely, there would still be iron and titanium in the layers then exposed, and the spectrum would still show their dark lines. The atoms with which we have to deal, then, are excited, not by radiation corresponding to the intensity of the spectrum in the bright parts outside the lines, but by something little stronger than the central parts of these dark lines themselves. This relatively feeble radiation corresponds to a lower temperature, and the main part of the difficulty is explained—though there is room for plenty of work still on details.

Before theoretical investigators get through with a complete discussion of what happens in the solar spectrum, it is likely that they will have to invent still more kinds of effective temperature—each with its own definition, and its own numerical value; but for the present we may have had enough.—*Ragusa, Jugoslavia, June 28, 1938.*

Drawings by Robinson and Steinman Consulting Engineers

General view of the International Bridge system. *Left to right:* **American channel crossing from Collins Landing, 800-foot main span; reinforced concrete bridge, 90-foot span, crossing International Rift and boundary; two 300-foot continuous truss spans; 348-foot span steel arch; Canadian channel crossing with a main span of 750 feet, terminating on the Canadian mainland near Ivy Lea, Ontario**

A Bridge of Peace

United States to Canada . . . Four Different Types of Spans . . . The Biggest Little Bridge . . . Triple-Function Pier . . . New Cable Anchorages Used

By D. B. STEINMAN

THE new Thousand Islands International Bridge, opened in August during a joint U. S.-Canadian celebration of 100 years of international peace, affords the student of engineering an opportunity to study an interesting and comprehensive project. Comprising five separate spans crossing the St. Lawrence River and Thousand Islands, the complete unit involves four different types of bridge construction. These are the two suspension spans linking the Islands with the Canadian and United States mainland; a double Ferris truss, a rigid formed arch, and a stone arch. The three last, with roadways, link the Islands with the two main spans.

Right: **The suspension-bridge crossing of the American channel nears completion; the steel deck ready for the road**

Below: **Workers high above the St. Lawrence River close the last gap in the roadway deck of the American channel span of the International bridge**

The official opening of this bridge was almost exactly a century after the last border trouble when William Johnston, colorful buccaneer of the last century, ended his "one man" Patriot's War against the British government.

The designing engineers have joined economy with beauty and practicality in utilizing natural topography and natural rock foundations to reduce total construction costs for the five spans and 8½ miles of roadway to $2,200,000. Engineers who planned the new steel and concrete path learned later that they had echoed an older judgement. Two centuries ago, Indians of the Mohawk Nation trekked across the frozen river over an almost identical course—the old Mohawk Trail immortalized by James Fenimore Cooper.

Favorable topographical conditions influenced the selection of bridge types,

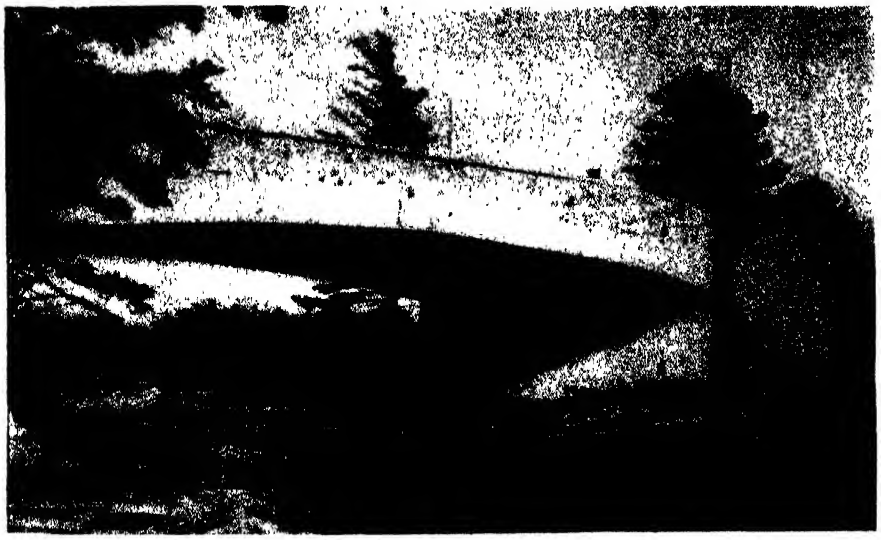
served to reduce costs of substructure to a minimum, and made possible several unique anchorage treatments. The cost ratio of substructure to superstructure is only 1 to 5 instead of being equal, as in the case of what is considered to be a normal economical plan.

Massive natural rock abutments on Constance and Georgina Islands were factors in the choice of the steel arch type of span. A sharply rising rock formation on Georgina's south shore, found ideal for both horizontal arch thrust and horizontal cable pull, is the scene of the project's outstanding engineering feat—a triple-function pier serving as the south anchorage of the suspension bridge, as the north abutment of the steel arch, and as the pylon forming the north end of the arch to support the connecting viaduct span and the arch floor panel.

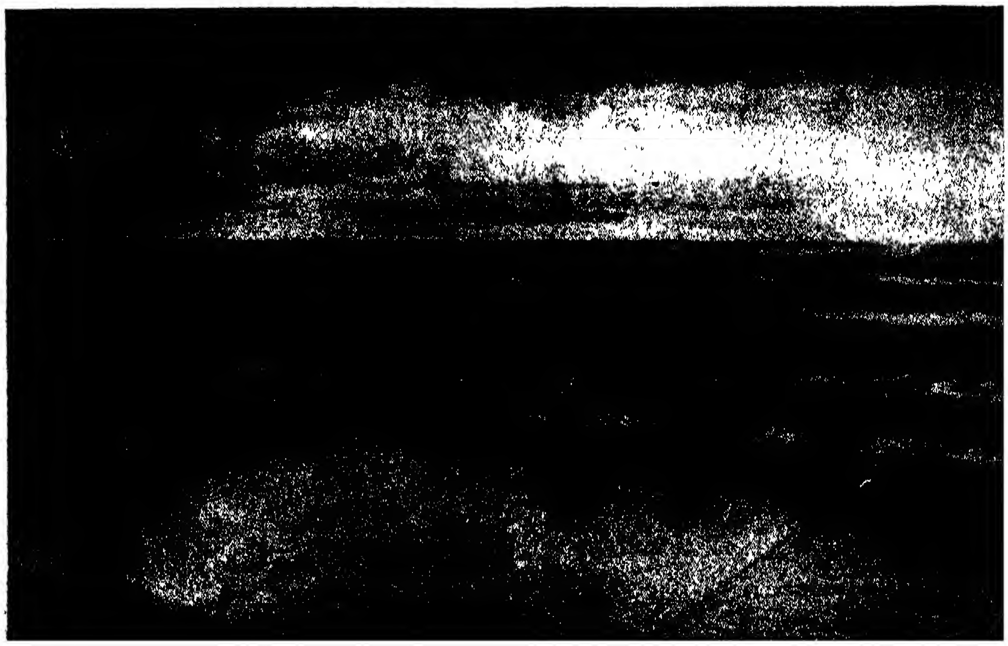
A new anchorage for multiple rope-strand cables, considered the simplest and most economical form yet devised, and invented by Dr. Holton D. Robinson, of Robinson & Steinman, designing engineers, has its original application on the project's two suspension bridges. In this new anchorage form, each of the 37 1¼-inch strands composing the suspension span cables, which are of prestressed rope-strand construction, is separately and adjustably connected to a projecting end of one of 37 round steel bars, 2⅜ inches in diameter and independently imbedded in the anchorage concrete. Each strand terminates in a steel socket which is externally threaded, opposite hand, and the upper end of each bar is upset and threaded. An internally threaded sleeve, turned by a wrench, serves for connection and adjustment between the anchor bar and strand socket. Following adjustment for length variations to assure uniform strand tension, the ends of the connecting sleeves are spot-welded to preclude subsequent rotation.

Above: **Continuous truss spans cross the historic Lost Channel from Hill to Constance Islands**

Right: **Fabricating the steel of the graceful arch that will support the span from Constance Island to Georgina Island, Ontario**



Below: **"The Biggest Little Bridge in the World," a 90-foot span, crosses the border of the United States and Canada**



Right: **From Canada to the United States. Compare with the drawing reproduced at the top of opposite page**

THE ENIGMA OF THE

What Radical Happening Produced Vast Submarine Canyons Comparable with the Grand Canyon? ... In Lively Fashion the Geologists Debate this Mystery

IF you examine a geology textbook of the late 19th Century you may find mention of the existence of valleys on the sea floor. Today's textbooks also give the same casual reference to these valleys. In recent years, however, largely as a result of the work of the United States Coast and Geodetic Survey, information has become available which indicates that these neglected submarine valleys include some of the deepest gashes in the face of the earth. In fact, the term "valley" is no longer appropriate. These depressions are so steep sided and so enormously deep that they should be dignified by the name "submarine canyon."

Withdrawal of the waters from the ocean would show these canyons as scenic features that would be almost without parallel. Even the Grand Canyon might be eclipsed by the most striking of these oceanic depressions. It is literally true that most coasts of the world have nothing above water that will compare from a scenic point of view with the canyons on the adjacent ocean floor. Thus there are canyons off the New England and mid-Atlantic states that have walls rising as much as 4000 feet above their bottoms. None of the New England nor even the Appalachian mountains have valleys that will hold a candle to these giant submarine features. Even off a low coast like west equatorial Africa there is a gigantic gash at the mouth of the Congo River which has been cut 4000 feet into the ocean bottom. Another off the broad delta of the Indus River cuts at least 3000 feet below the surrounding sea floor.

A few of us have been investigating these submarine canyons. Where we have made detailed examinations, we have found that they are in every way comparable with the river-cut canyons of the land. They have the same V-shaped cross-sections. They have winding courses like river valleys on land and they even have the same types of tributaries extending into the main canyons from either side. Also, they slope outward along their channels as continuously as do river valleys. In some cases, as at Carmel Bay, California, river canyons on land can be traced directly out into submarine canyons of exactly the same character. They are found off many of the large rivers of the lands, such as the Hudson, the Mississippi, the Francisco of Brazil, the Salinas of California, the Columbia of Oregon, the Ganges and Indus of India, the Congo and Niger of Africa, and the Adour of southwestern France. All these points lead to the conclusion that the canyons were cut by rivers at a time when the water did not cover the present oceanic slopes and that subsequent submergence has brought them to their present position.

Against the river origin various geologists are raising a storm of protest. Nor is the solution of the problem as simple as might be supposed. Here are some of the difficulties which confront the river erosion hypothesis:

If you partially submerge a model of a mountain slope cut by canyons the water will extend up the canyons, forming bays and leaving the ridges standing out as peninsulas and capes; but the coasts adjacent to the submarine canyons are commonly straight or almost straight, as for example the coast of California or the southern coast of western France.

Courtesy Blackstone Model Co.

A scale model of the big Monterey submarine canyon, off the California coast. It extends to 10,000 feet depth

Because sea-bottoms are supposedly not dissected by stream erosion, coasts with indications of considerable uplift might be expected to be free of adjacent submarine canyons, and yet it is off such coasts that many of the deepest canyons are found.

Geological work on the land areas has shown that some coasts have been elevated and that others have sunk, but that most coasts have been extremely stable for long periods. Accordingly, it is surprising to find that deep submarine canyons with their indications of enormous sinking exist along practically every coast of the world.

IT might be supposed that if the continental margins have all been greatly depressed, the downward movements would have taken place at a variety of times during the past. However, we are discovering more and more evidence in the form of fossil-bearing rocks dredged from the canyon walls to show that the canyons were made in relatively recent times and, therefore, must have been submerged even more recently.

Is it any wonder that a recent geological metaphor is "as puzzling as a submarine canyon"? Picture the dilemma of the poor geologist with his past experience and his logic telling him that submerged river canyons simply should not exist off such a coast as California which has been uplifted, and certainly not off that remarkably stable New England coast, and yet finding off these places features which are the twin sisters of the land canyons which he knows to have been cut by rivers.

A model of a group of deep submarine canyons found off the coast of New England. Their origin is unknown

As a result of this quandary, proposals have been coming out to the effect that the submarine canyons are the result of processes which could operate on the ocean bottom. The authors of these

SUBMARINE CANYONS

By FRANCES P. SHEPARD

**Associate Professor of Geology, University of Illinois
Research Associate, Scripps Institution of Oceanography**

The *E. W. Scripps*, 104-foot auxiliary schooner belonging to the Scripps Institution and being used under a co-operative arrangement with the Geological Society of America for investigations of the ocean floor, including the canyons

ideas seem to have been rather poorly informed of the characteristics of the canyons and have in general failed to answer objections to their hypotheses. For example, the idea that downward movements of the earth's crust produced the canyons is disproved by the pattern and shape of the canyons: they are entirely different from those of land valleys produced by movements of the crust.

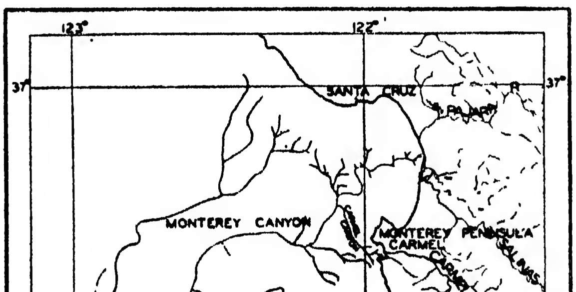
AN idea which has more support than that of earth movements is that there are or have been currents moving down the submarine slopes and cutting canyons into them. It has been suggested that waves beating against the coast and stirring up mud might make the water so heavy that it would slide down the slopes and produce this cutting. However, such an explanation fails to account for the typical river pattern of the canyons and for their relation to many of the largest rivers of which they are extensions. Nor does it explain the existence of many canyons directly off sandy or rocky coasts where mud would not be accessible to produce the currents. Furthermore, it is highly improbable that muddy water would set up currents of sufficient force to excavate enormous canyons out of solid rock formations.

Other geologists, accepting the implication that the canyons were cut by rivers and realizing the improbability that all the continental margins had been recently depressed, have resorted to the alternative of sea level change. Thus it has been suggested that the whole Pacific Ocean basin sank, drawing off the waters from the coasts of the world. This would have allowed the canyons to be cut and a return of the ocean floor to its former position would have drowned the canyons. Sank!—but into what could the basins sink, since the earth's interior is known to be solid? Furthermore, the islands in the Pacific have submarine canyons, hence they were involved in the same changes as the continental margins. Probably we have little help from this source. A still more fantastic notion is that the earth's rate of rotation was suddenly decreased by a collision with a heavenly body and that, as a result, the oceanic waters were thrown toward the pole, permitting canyons to be cut into the exposed slopes of the equatorial regions. Subsequently, drowning of these canyons would have occurred when the earth's surface had bulged sufficiently at the poles to be adjusted to its new rate of rotation. Unfortunately, even if such a thing could have happened, it would not explain the canyons since they should all be found near the equator and should completely disappear at 35 degrees of latitude, but it is north of that latitude that all the deepest well-surveyed canyons of the world have been found.

One thing is perfectly evident, namely, that we will never solve the enigma of the submarine canyons by devising hypotheses which do not take into consideration the facts of the case. The present writer has been gathering these facts from all over the world for the past 15 years. There is still much to be desired and it is only during the past year that it has become possible to begin extensive and systematic observations with all the expensive equipment necessary for such studies. However, there are already some indications of a solution of the canyon mystery.

The difficulties confronted by the submerged river canyon hypothesis would fade if the following contentions could be demonstrated:

1. That the canyons have been submerged long enough to allow the adjacent coasts to be straightened by waves and currents. 2. That the sea level was greatly lowered by the extraction of water from the ocean and piling of this water on land in the form of continental glaciers. This would have allowed the cutting of canyons by the extended streams off all the coasts of the world and off the oceanic islands. Then the melting of the glaciers would have drowned the canyons. 3. That the outer portions of the submarine canyons were formed independently of the lowered sea level by a variety of processes.



Courtesy Proceedings of the National Academy of Sciences

Part of California (to the right) and canyons on adjacent sea-bottom, exhibiting stream patterns

It has been shown that enormous quantities of sediment are being carried toward the submarine canyons either by rivers entering at their head, as in the case of the Congo where a submarine canyon extends well in toward the shore line, or by currents as in the case of southern California where enormous movements of sand along the coast are shown by the fills behind breakwaters and next to piers. Despite this fact some canyons come up almost to the beach. If these canyons have not been submerged recently, why are they not filled? The an
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water. These movements, which are probably of the nature of mud flows, have been known to occur after earthquakes. For example, the canyon off Yokohama was found to be hundreds of feet deeper after the great Japanese earthquake of 1923 and this deepening must have been due to sliding of the bottom material since it is far too great to be accounted for by sudden crustal movements. More recently, checking of the depths at the head of a canyon off the coast at La Jolla, California, has led to the discovery of landslides in operation. The slow progress of one slide was charted and a large crack was found to open on the side of the canyon. Later the block on the seaward side of this crevice was detached and slid out to sea, leaving the canyon considerably wider than it had been previously.

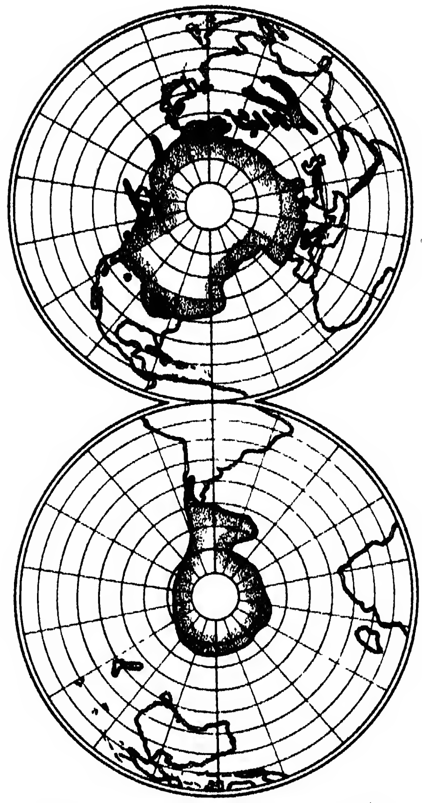
THE significance of these mud flows and landslides is that they make it possible for the canyons to have been submerged for indefinitely long periods without filling and certainly for long enough time so that the rivers and waves could have straightened the adjacent coast, by filling in the heads of the bays which resulted from the canyon submergence.

With regard to the lowering of sea level due to the forming of great continental glaciers, there is no question but that the glaciers during the ice age received their water from the ocean due to evaporation and later precipitation of the water vapor in the form of snow. As this snow accumulated on the land the ocean level was reduced by an amount corresponding closely in volume to the growing ice sheets. The question is whether the ice caps could have been large enough to have produced the lowering of thousands of feet which are essential in order to make this idea of any consequence. It has been estimated that the sea surface was lowered only 300 feet from this cause, but such an estimate is very conservative and it doesn't look as though we were going to solve the mystery of the submarine canyons by conservative speculation. Something pretty radical must have happened.

The Soviet geologists have been mapping the evidence of glacial action in northern Russia and Siberia and their latest report shows that all over this territory the ice caps moved onto the lands from the north where the Arctic Ocean now exists. These findings may be interpreted as meaning that there was a great ice cap centering in some place in the Arctic, perhaps northern Greenland. From this the ice spread on the one hand into North America and the other into northern Europe and Siberia. What, after all, could be more natural than to have an ice cap in the northern hemisphere with a center near the pole, similar to the Antarctic ice cap in the southern hemisphere?

Furthermore, a great enlargement of the Antarctic ice cap may have occurred. These huge masses of ice in both hemispheres may have grown till they became several miles thick; certainly an average of four miles is a reasonable estimate. The result of such caps would have been the lowering of the sea level to an extent which would at least have been a great help in explaining the submarine canyons.

On the other hand, if the ice had lowered the sea level as much as 10,000 feet, which may be necessary to explain the deep outer portions of some of the canyons, there would have been so little water left in the basins that practically all the marine life would have been killed by the great increase in salinity due to such concentration. There is no evidence of great extinction of life, nor is it likely that the ice could have grown till it produced a 10,000-foot lowering. These outer portions of the canyons are for the most part only poorly surveyed, so that we do not know whether they represent the same river canyon types as the inner portions. It is not unlikely that they were formed in some other way. There are plenty of irregularities on the deep sea-bottom, due to crustal movements and to sub-oceanic volcanic activity. It is quite conceivable that, when the waters were lowered by the glacial period, rivers flowed into pre-existing depressions on the former ocean bottom and cut their canyons in continuity with these features. Also, it is very likely that some canyons have been depressed over a long period of time by earth movements till they reached great depths.



The possible distribution of ice during the maximum of glaciation

It is, of course, impossible to tell whether new information will finally demonstrate the correctness of the hypothesis which has been outlined. On the other hand it is safe to predict that the ultimate explanation of the canyons will be equally revolutionary so far as the science of geology is concerned, and will probably have an important bearing on the other natural sciences of the earth.

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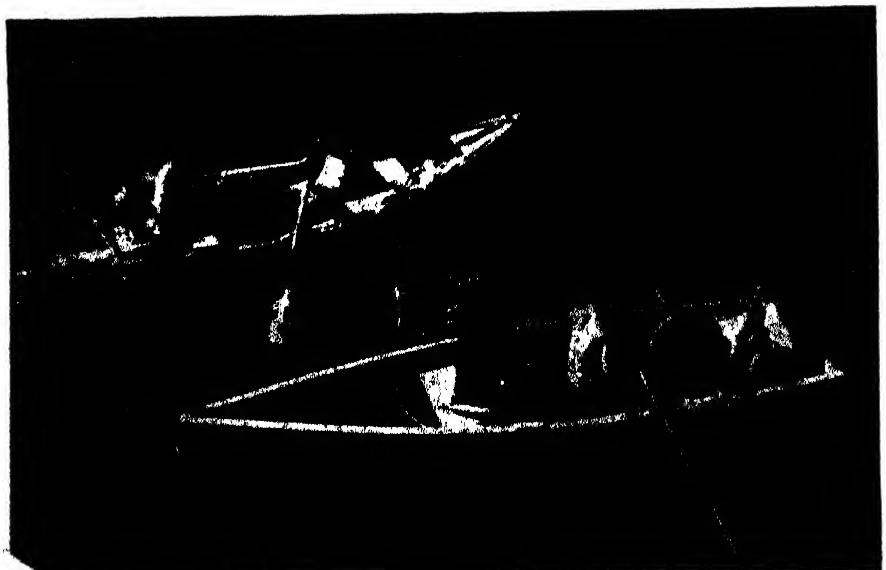
In recent geological and other professional journals there is a growing literature on the submarine canyons. The American Philosophical Society, Independence Square, Philadelphia, Pa., has recently published a book containing a number of papers delivered at a symposium on this subject, with the discussion that followed the symposium.



of all boats used near the Scripps Institution, of La Jolla, California, for re-
fornia, such as charting minor changes in the heads of the submarine canyons

VEGETARIAN CHINA

For Centuries China Has Unconsciously Been Working Out a Vast Food Experiment From Which the Western World Can Learn Practical Lessons

By WILLIAM H. ADOLPH
Professor of Biochemistry, Yenching University, Peiping, China

RURAL China has furnished what is probably the best large-scale, long-term experiment with a vegetarian diet which the modern world has witnessed. Vegetarian fads in our Occident have come and gone and, while enthusiasts still stage occasional revivals, it is probable that as an accepted nutritional regimen, pure vegetarianism is on the wane. By vegetarianism is meant eating food which is solely of vegetable origin. The ration therefore does not include milk, milk products, meat, eggs, or other food-materials derived from animal sources.

The experiment which the rural populace of China has been carrying on is in many respects unconscious, but one source of its importance lies in the fact that it is unconscious. Another reason for its importance is the fact that it has involved not merely a few selected white rats, or even a few human subjects sheltered in the artificial comforts of the nutrition laboratory, but several millions of people as experimental subjects. Furthermore, it has extended not over a few weeks but over a score or more of centuries. It is estimated that not more than 10 percent of China's population live in the cities, and the food habits of the remaining rural 90 percent have remained largely unaltered, even as the agricultural economy has remained largely unchanged, over a period of thousands of years. The solution to its foremost problem which China has reached—that is, the problem of maintaining a large population on an agricultural basis—is therefore worthy of study. In fact, such a state of nutritional equilibrium as has been attained with human subjects in this area of eastern Asia is unique in the realm of nutritional investigation. Moreover, with the economic factors of the modern world rapidly changing, the opportunity which this experiment offers for study will quite probably never exist again.

Figure 1 is based on a number of preliminary surveys of what Chinese natives eat. It provides a comparison of the average dietary of China with that of America. Also, it indicates the almost complete extent to which the Chinese diet is vegetarian. In the Chinese diet, meat, fish, and eggs furnish only a very small amount of the total food supply. Even then many observers feel the figure indicated for meat—3 percent—is too high and does not properly represent the facts, while the milk and milk products consumed in China are so small in amount that they do not appear in the diagram at all. The amount of milk consumed averages less than 0.1 percent. It is of no small moment to realize that this large rural community of several hundred million people has lived and survived for, say, 40 centuries without milk as food and without the use of any kind of dairy industry. Nor can it be asserted that the net result of this national experiment is qualitatively inferior, for example, to that of the Mongols to the north of the Chinese who do consume milk. Nor is this result in any sense culturally inferior to that of non-vegetarian countries.

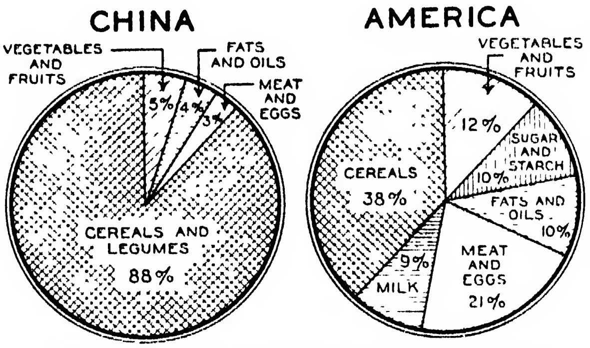


Figure 1: **Even an avowed vegetarian in the Occident might find himself hungry for foods of animal origin —butter, eggs, milk—if he ate a rural Chinese diet**

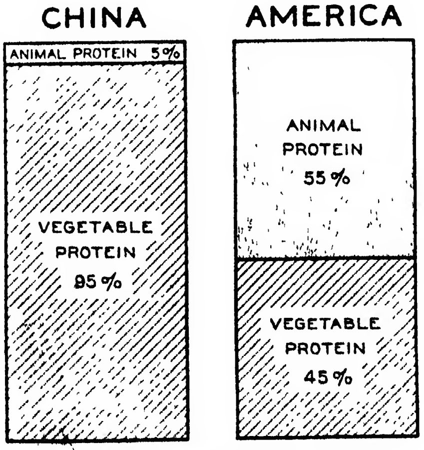


Figure 2: **Like it or not, China's peasant must get his protein—all but 5 percent—from vegetable foods**

The same diagram shows that the American dietary is a true omnivorous diet and, while it is not a perfect diet in many respects, it does provide what the nutritionist terms a well-balanced intake.

The vegetarian diet of China is, strictly speaking, a cereal diet. Legumes—and this includes the soybean—are here included in this cereal group. The cereals consumed in North China (generally eaten as bread) are mainly wheat, millet, corn, and kaoliang; the southern Chinese replace these by the single cereal, rice (steamed rice). The customary reference to China as a rice-consuming nation applies, it should be observed, only to the southern two thirds of the country.

A MORE careful analysis of the data from dietary figures for China shows an apparent shortage of two items—calcium and protein. The first of these, calcium, is closely related to skeletal growth and stature. The amount of calcium consumed per capita throughout China appears to be not only dangerously near the minimum amount consistent with health and vigor but, according to western standards, it is far below that amount. An abundant supply of calcium is related to the use of milk. American nutritionists, in fact, are accustomed to look to milk to supply practically the entire calcium need of the human organism, and the one quart of milk per capita per day recommended by the Occidental nutritionist for the growing adolescent is largely dictated by this need for calcium.

The protein factor, on the other hand, involves a question of quality rather than one of absolute quantity. Figure 2 indicates the extent to which the protein consumed is derived from animal sources (meat, milk, eggs) and vege-

table sources (principally cereals). Protein studies show that vegetable proteins have many shortcomings; they are less completely digested in the alimentary tract, and the portions digested are intrinsically of lower nutritive value. This means that, from a purely quantitative angle, more vegetable proteins must be eaten to meet the requirement. If 60 grams (two ounces) of protein per day are recommended for the mixed meat-milk-vegetable diet, probably 80 grams per day should be the intake on a more strictly vegetarian diet.

One of the interesting results of the Chinese experiment is the unconscious but independent discovery by the farmer-consumer that bread made from a mixture of cereals is usually to be preferred to that made from a single cereal. Various types of mixed flour are found native to different areas in North China. Crop conditions in each district dictate different mixtures, but in almost every district the farmers report a conviction that the mixed flour is superior to any one of the constituent simple cereals. Exact laboratory measurements have only in recent years demonstrated that this concerns the protein factor, for mixed cereal protein has an enhanced nutritive value. It is no longer regarded as surprising when laboratory experiments confirm the findings of the ages! Figure 3 shows the growth curves obtained when mixed cereals from representative rural districts in North China were fed to laboratory test animals, in such a manner that the protein constituted 10 percent of the food.

FIGURES 4 and 5 illustrate the results obtained with laboratory white rats, using littermates of the same age and initial weight, when fed typical omnivorous and vegetarian diets—in both cases the rat that received milk grew far larger and heavier than the other. It must be kept in mind that an experiment with laboratory animals, under controlled conditions, accentuates one particular factor and purposely overlooks the many other physiological factors to which man in daily life is subject and which in human practice would also affect the results. The results pictured here, from the Yenching University laboratory, are, however, typical of many growth experiments carried out with vegetarian diets. In the Peiping Union Medical College, under the direction of Dr. Hsien Wu, attempts were made over a period of years to find a combination of vegetable materials which would produce growth in white rats comparable with that produced by an omnivorous diet, but the search did not lead to success. As a result, nutrition laboratories in the Orient which maintain rat colonies and raise white rats for experimental purposes, have found it advisable to feed these animals with a stock diet containing an appreciable amount of animal protein. This may be meat protein, casein (from milk), or even milk itself in some form. Results obtained with white rats may not be directly applicable to man, but the experience of nutritionists indicates that these qualitative differences between vegetable and animal protein cannot be overlooked.

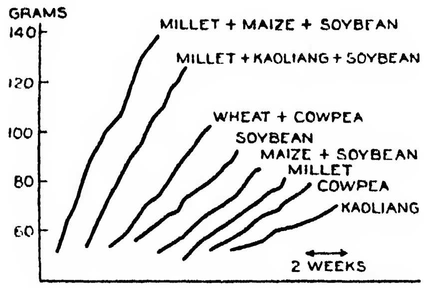


Figure 3: Modern science proves that the whole exceeds the sum of the parts. However, China learned this fact empirically, centuries ago

Many of the food habits of the Chinese people, however, involve questions of food economics. Milk has never become a substantial item in the dietary. The reason is related to economic factors. The agricultural economist explains that calling upon a cow to eat cereal and convert this into milk, which in turn is then consumed by man, involves a greater energy loss than allowing man to consume the cereal in the first place. If man can actually convert cereal food directly into human brawn and human energy, then a cow becomes only an expensive intermediary. Such economic facts, particularly when the tremendous loss involved in a "cow converter" is weighed, become part of the inarticulate nutritional experience of a people. The same line of experience applies to meat, which is an expensive food in the Orient. When meat as a food is measured in a similar way it is found that the process of changing the agricultural crop into beef before it becomes human food involves a similar conversion loss. Animal husbandry furthermore has demonstrated with regard to meat production that the crop yield of a given unit of land area, if used to feed farm animals, will produce twice as much pork as beef—a fact that may be connected with the well-known prevalence of pork over beef in China. It has also been similarly suggested that *steamed* bread, because it is prepared with the expenditure of much less fuel than baked bread, has become the bread of North China, due to an economic factor.

THE laws of supply and demand are related, of course, to the province-wide task of feeding large populations. Food consumption is readily estimated directly from the crops grown, for in China no significant amount of food is transported from one province to another. The close relationship between crop-production and population is suggested in Figure 6. The calculation shown in this table takes Shantung province for an example and merely converts the food yield of a given area into food calories available per capita of population. The figures indicate that, for a typical agricultural community (an area without extensive industrialization) this province can provide just barely enough agricultural product to support its present population. There is certainly no margin! Shantung is typical of the region of the Yellow River delta. The population is dense and the area averages hardly more than one crop per year. Other formulas for estimating population pressure yield similar results. Significant population facts for Hopei, another of the north China provinces, are illustrated in Figure 7.

Nutritionists during the past decade

Figure 4: Rat at left ate a wheat-milk diet and outweighs its undersized rice-and-vegetable-fed littermate 252 percent

Figure 5: Rat at right grew up on a milk-meat-egg-vegetable diet. It outweighs its vegetable-fed littermate 390 percent

have turned from a discussion of what is the *minimum* diet to a consideration of what is the *optimum*, or best, diet. Superior effects measured in terms of growth in weight have been many times reported for laboratory animals when the amounts of certain chemical essentials in the diet have been augmented. Especially favorable results have been obtained by increasing the calcium and the milk protein, as well as the vitamins. Measurements in the United States indicate that during the last half century there has been a marked increase in stature and physique in the younger generation of Americans. This may be attributed to improved living conditions, but among these conditions the improvement of the diet is certainly a leading factor. This observation is paralleled by results obtained at the Connecticut Agricultural Experiment Station where one of the oldest and largest of the white rat colonies used for nutrition experiments is housed and has been kept under careful observation. These animals have been fed the best diet available. A recent report shows, however, that in this colony over a period of 25 years there has been a gradual improvement in growth as new discoveries in nutrition made possible successive improvements in the stock diet fed. This growth performance is represented by the curves shown in Figure 8; these curves indicate averages, of course, for a large number of rats. In the same way in man the norm of growth may be rising. No one has yet accurately defined the upper limit of increased stature and physique which may be reached with improvement in the diet. It is evident that many of these factors are subtle, and that such experimental results often become apparent only when the experiment is extended over many generations. We can merely ask: How far can such an increase be continued? Is there an optimum physique for the animal and for man which we have not yet attained?

Calculation of Food Supply

Province of Shantung

Average Crop Production (wheat as an example; 1 kilo of wheat equivalent to 3500 calories)

Yield, 1 crop per year, per hectare (2.5 acres) = 1000 kilos, equivalent to:	3,500,000 calories
Area of province	14,000,000 hectares
Tillable area (estimated)	10,000,000 hectares
Population	37,000,000
Tillable area per capita	.27 hectares
Producing food energy (1 crop per year) per capita	950,000 calories
Per capita equivalent in food energy per day	2600 calories
Energy standard for man doing light work	2400 calories

Figure 6

The bare fact remains that the Chinese peasant has maintained himself for 4000 years or more on a diet which is not only vegetarian but which does not contain milk, the *sine qua non* of the western dietitian. Milk is the one item without which our nicely balanced calculations become sadly deranged. Nevertheless, not only do simple calculations demonstrate that in China a nation-wide dairy industry is at present impossible, but history would seem to indicate that the Chinese people have never used milk.

The low calcium intake mentioned above causes the eastern dietitian some concern, for instead of milk, which in other countries is the chief source of calcium, the Oriental must seek vegetable sources of calcium to bolster up this supply. The amount of calcium consumed per capita per day is startlingly low by western standards. The importance of this element lies in the fact that calcium is the chief constituent of the bones and skeleton, and it seems likely that the low calcium intake is one of the limiting factors to which the Chinese physique has had to adjust. It has been naively suggested that the lower stature of the Oriental races is the result of this adjustment! This is only a conjecture, but it reflects some of the basic facts which the nutritionist may be called upon to explain! What is a nutrition standard? It may be wrong to refer to the diet of the Chinese peasant as a deficient diet. May it not be true that observations on long-term experiments, such as the Chinese experiment, will assist the world to establish truer norms? If so, we can look to the Orient for a more satisfactory definition of many of these dietary values.

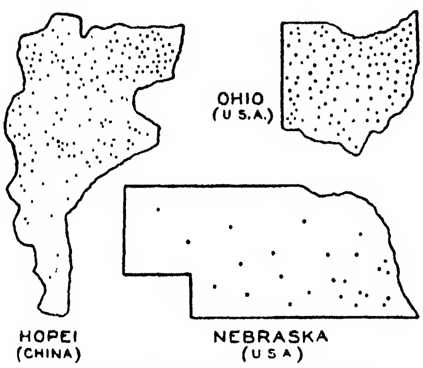


Figure 7: Each dot represents 50,000 population. Let the Nebraskan, or even the Ohioan, imagine what his state would be like under the population pressure of Hopei Province

It is impossible to discuss here other important aspects of China's vegetarian experiment. The problem of vitamins in the vegetarian diet forms a distinct chapter; the effect of high carbohydrate diet with its abundance of roughage is another; the soybean in China's dietetic repertoire is still another episode whose importance America has just discovered; there are other unique contributions. It may be concluded that, in the realm of rural nutrition, China has attained a solution to her food problem which economically is creditable and intensely practical, but qualitatively, the verdict declares, there is ground for much improvement. Improvements which health officers and nutritionists are proposing will involve decreasing the percentage of cereals in the diet and increasing the amount of green leaf vegetables and tubers such as sweet potatoes, and also the greater use of eggs as food; these changes possibly can be brought about without serious jolts to the agricultural economy. In addition to these, most programs propose rapid industrialization which, by raising the economic level, will enable the individual to expand the food budget and will make possible the beginnings of a dairy industry. Industrialization may thus be defined as a device to relieve the pressure on the land! Health education is receiving special attention. All the nations of the world are absorbed in the task of developing national vigor and physique. Nutritional science in the Orient has only begun to apply itself to the problems at hand.

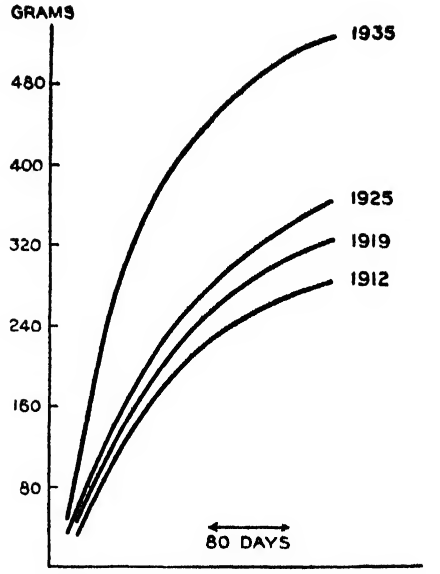


Figure 8: Generations of improved diet work changes on rat growth

MAN has for many years been aware that there was some relationship between food and physique, but the realm of nutrition is being expanded to include other qualities than mere growth. The president of the American Medical Association recently proclaimed that the newer knowledge of nutrition promises "greater vigor, increased longevity, and a higher level of cultural development."

Turning 'Em Around

Cargo Ships Unloaded, Reloaded Speedily, Efficiently . . . Method is Exacting . . . Stevedores Supervise, Arrange Cargo . . . Difficult Details

By DAULTON MANN
Executive Vice President, Grace Line

ALONG the South Street of 19th Century New York, bowsprits protruded over the sea wall almost to ship chandlers' doors. Out of the holds of sleek clippers came silks, teas, rare woods, and bric-à-brac, all the lush wealth of China and India, to be hauled away over the cobble-stoned waterfront street by four-horse teams. Today, huge motor-trucks laden with machinery, tires, airplane propellers, copper, steel rails, auto chassis—the products of a highly industrialized society—crowd the docks of New York City.

Instead of the uncertain cargo movements of sailing days, these goods move between ports today on schedules which are clock-like in their regularity. A hundred years ago perishable cargo was nearly unheard of, but now fast freighters, equipped with modern refrigeration, carry fruits from California, bananas from Central America, meat from the Argentine, to the ports of the world.

Few nations are as self-sufficient as the United States, yet this country must import many of the materials for one-time luxuries—present necessities which mass-production technique has transformed into household articles. For the tremendous electrical industry, 17 nations ship materials to the United States. The radio's countless parts travel about 250,000 miles before assembly at the factory.

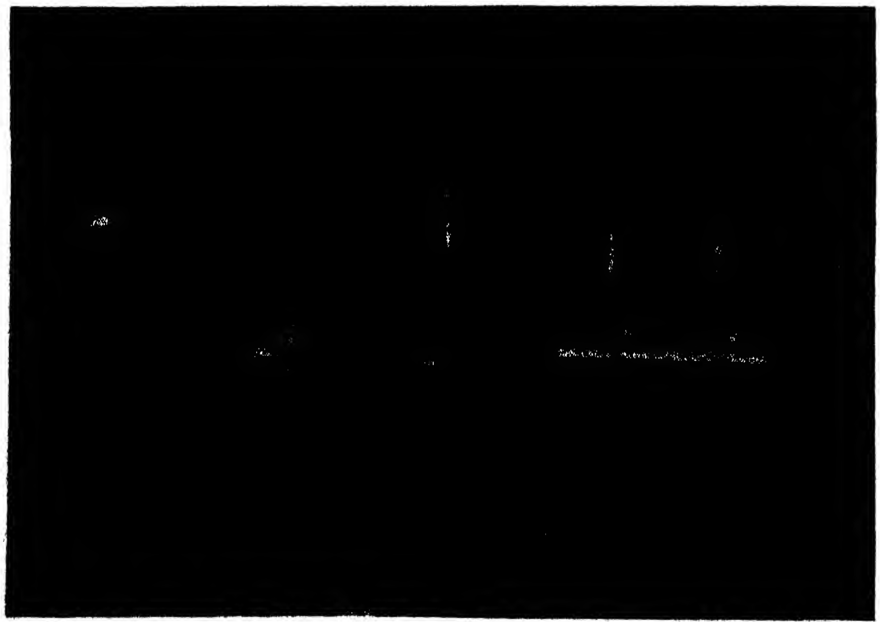
But countries like the United States and Great Britain, which have built up huge industrial centers, export great quantities of manufactures. During 1937 alone, the United States exported goods valued at about $2,453,056,000. And 80 percent of all American exports are transported by water.

During the year ending December 31, 1936, about 8591 vessels entered the port of New York and about as many left. In the holds of incoming ships were 34,000,000 tons of merchandise; and ships, leaving for foreign ports, carried 11,500,000 tons of freight. Valued at over $2,000,000,000, this import and export cargo was entrusted to the care of stevedores who unload and load the freighters, tramps, and combination passenger and cargo vessels which dock at New York's North and East River piers. To facilitate the movement of this freight, about $1,000,000,000 has been spent on piers, warehouses, drydock, and other necessary equipment.

Definite problems — technical, geographic, and labor—face the shipowner in the movement of water-borne cargo. From the point of view of variety of cargo and ports of call, Grace Line is an example of modern cargo handling at maximum efficiency. From the North River pier, in New York City, south to Valparaiso, Chile, the ships of this line stop at more than a dozen ports which bridge the gap of temperature from winter to summer and present varying problems of unloading and loading from lighter to ship, or from dock to ship. Because of these natural difficulties the handling gear is of special design—hatches are unusually large and the old donkey engine has been replaced by the electric winch. The Grace Line's schedule of operation is based on a quick turn-around, necessitating the utmost ingenuity in handling cargo with the greatest possible speed. The man who makes this possible is the stevedore.

ALL repairs, painting, and renovating are done in port by shore gangs employed by the shipowner. Once the ship is unloaded, a gang of men cleans out the hold before the job of loading the ship with new cargo is begun. The unloading and loading are done by the stevedore; he is no unskilled laborer doing his job by rule of thumb, but an important cog in the business of ocean shipping. Upon his skill depends, to a certain extent, the safety of the ship at sea. Yet his work begins and ends at the pier; he never goes to sea. The quick, sure movement of freight is largely due to the efficiency with which he performs his task. The stevedore is a skilled member of an essential craft; he is a supervisor and directs the loading and unloading of the ship and has charge of what cargo goes where. On the other hand, longshoremen are laborers who work in the ship's holds, on the pier, or on lighters, and who stow away the cargo.

There are certain general factors which ease the task of loading ships. As a rule, a ship line will consistently transport one type of cargo out, while another general type of cargo will be imported. For example, Grace Line ships going south always stop at the same ports, and carry cargoes of finished goods, manufactured products. Returning north,



From piles on the pier, most cargo is loaded by trailers or by derricks. This electric hoister lifts a skid-load of barrels and will carry them to the proper pile

these ships mainly carry raw materials such as beans, wool, copper, coffee, and tobacco. Therefore, for all ships carrying cargo on definite schedules, the cargo stowage plan is uniform.

When cargo reaches the pier, or is brought alongside the ship by lighter, a cargo checker notes the bill of lading (size, weight, and quantity of cargo), checks the measurements, and makes out a dock receipt. A carbon copy is attached to the shipment. On this carbon copy receipt is a description of the cargo and the weight of the shipment.

As cargo accumulates, the pier superintendent begins to check his loading lists, noting the weight-ton and stowage-ton. Stowage-ton is calculated at one ton to 40 cubic feet of space, and shipowners have the choice of charging per weight-ton or stowage-ton. If the shipment is copper, which weighs so much more per cubic foot than wool, the freight charge would be by weight-ton.

For hoisting aboard liquid-filled barrels, perhaps those shown in the opposite photograph, spreader bridles and skids, upon which the barrels rest, are used as in the illustration above

After sorting out the varied shipments, the pier superintendent must next solve his labor problems. Perhaps the ship has docked at New York on Tuesday at 9:00 A.M.; then, at 5:00 P.M. on Friday, she will leave for Chile. During the short interval, cargo must be unloaded and shipments out of New York, as well as the ship's stores, must be put aboard. The stores are routine work, but the cargo is a weekly headache. Whether it is a job of loading or unloading, the pier superintendent knows, from the manifest lists, the amount and type of cargo which must be handled. Also, he knows how many tons the ship can load and unload per hour. Thus, from the manifest lists and the ship's capacity for working holds, he can tell how many longshoremen he will need to load the ship. He hires these laborers to work in eight-hour shifts, for loading a vessel is a 24-hour job; work goes on day and night, often up to within an hour, or even less, of sailing time.

His labor problem settled, the superintendent studies the nightmare task of loading the ship. It must be done most economically, and in such a manner as will provide for the most efficient discharge. There is a stated amount of cargo to be shipped. But there is the inexorable fact that the ship can carry only so much freight. Will there be an over-load—an excess amount of cargo which can be loaded on the deck? Or had the shipments of rails for Cristobal better wait for the next ship south? Would it be more economical to ship the crated automobiles this trip and unload and reload them five times before reaching their port at Salaverry, Peru, or delay shipment until the next ship leaves for South America? Within 24 hours after completion of the superintendent's loading lists, other freight may have been booked; where will this cargo go? He has to find a place for it. With such problems vexing him, the pier superintendent struggles with the puzzle of allotting cargo. It's a magician's hat trick in reverse and on a gargantuan scale. The problem is not *what* things come *out*, but *how* to get the known objects *in*.

In charge of all loading is the Chief Mate. In the ship's chart room is a plan of the ship's holds; as the freight is placed aboard the vessel, the cargo is plotted on this plan. In each hold is an officer and a checker; the officer notes the port and stowage in a "cargo book," while the checker jots down each shipment as it is stowed away.

The actual work of loading, however, is in the hands of the stevedore. The stevedore divides the cargo according to ports (away from the home port this is done by the Chief Mate). From the pier superintendent, the stevedore receives the distribution list, which describes the cargo, tells the amount of each shipment, and where each allotment is to be stowed.

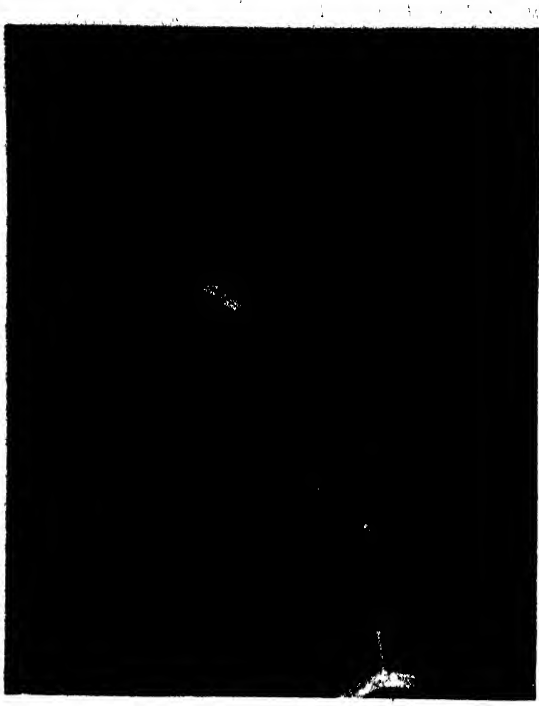
When the ship arrives at the pier, the stevedore's work begins. On the pier he must separate valuable cargo and perishable shipments from the rest of the freight. The cargo is further divided up into heavy and light cargo, into character cargo (such as "reefer" cargo—freight kept under refrigeration), and according to port. Then the cargo is ready for loading.

Looking down into the hold of a ship is almost a dizzying stunt. As though in a deep well, men are working far below, swinging bulky machinery, copper ingots, or boxed automobile parts into position while the derrick booms swing high overhead. Each hold aboard Grace Line ships is divided into three sections: lower hold; next, 'tween deck; and last, next to the hatch, the cover of the hold or the shelter deck. (This is the general American below-deck plan. The English is: lower hold, orlop deck, 'tween deck, shelter deck.)

DEFINITE rules for loading ships have evolved from experience and common sense. Cargo is loaded with two requirements in mind—safety and accessibility. Cargo is a ballast, and improper loading will affect, dangerously, the balance of a ship. Poor loading will make the ship sluggish in rough weather, cause the ship to list dangerously in choppy seas because of shifting cargo, make the ship too heavy forward so that she buries herself in high seas, or too light and thus put an undue strain on the ship's hull. Heavy cargo goes into the lower hold, but some heavy cargo is also distributed between 'tween deck and shelter deck so that the ship will be neither too tender nor too stiff in rough weather.

For certain light cargo, rope or wire net slings are used for lowering; box and crate slings for heavier cargo; wire cables and chain for machinery and steel rails; canvas slings for bags and flour; barrel hooks for kegs, and so on. In some cases, automobiles are driven right into the ship's hold through side ports; in other instances they are hoisted aboard by the ship's derricks.

In a ship loaded in New York for Valparaiso, cargo for the last port is loaded first, and that for the first port last. But not all shipments for one port are loaded



Number 3 hold of the *Santa Lucia* (left) showing the lower hold, far down; next, the 'tween deck; and last, the shelter deck. Often loading and unloading go on at the same time, as is the case here. Copper bars are being hoisted out of the hold; the longshoreman has just hooked on the "Burton hook" coupling the "Pennant" to the "cargo fall" to swing the load over the ship's side. *Below:* A seated ship's officer checks off shipments as longshoremen level off cargo being lowered into the hold in slings

into one hold, for this would slow up loading and discharging. Instead, shipments for Callao, Peru, will be distributed among as many holds as possible so that the maximum number of holds can be worked at one time, thus facilitating the unloading of the ship and reducing the number of man-hours of work. Economy is, in the shipping business, a shrew of a taskmaster.

But regardless of the orderly loading of cargo according to ports of call, there are other trials and tribulations to vex the stevedore. Certain types of cargo cannot be placed together, and certain other cargoes must be isolated. The stevedore may tear his thinning hair, but these rules are inflexible.

All moist freight—or liquid—must be separated from dry goods, since moist freight tends to cause injury to cargo which must be shipped dry. Oil and turpentines are never stowed in the same compartment with wool, flour, or sugar. However, cotton, a dry cargo, must be segregated from all other shipments and is usually protected with 'tween deck hatches, thoroughly secured. When damp, cotton is subject to spontaneous combustion. All freight with cotton's similar combustible nature is placed far from passenger and crew quarters, boilers and bulk-heads.

Other freight also must be given special compartments. Certain moist cargo doesn't exude the pleasantest of odors, and some types of material were never intended for perfume: these cargoes must be stowed far away from green fruits, foods, and similar freight.

Aside from proper distribution to protect cargo from spoiling, mechanical precautions are taken. Certain freight, including foods, must be kept at definite temperatures to prevent spoilage. Modern cargo ships today are equipped with the finest of mechanical refrigeration. Cargoes which must be kept at certain temperatures will be placed in refrigerated holds and kept at the required temperatures throughout the voyage. In the Chief Engineer's log room are gages which keep a record at all times of the temperatures in the ship's massive refrigerators and these data are regularly checked by assistant engineers in charge of the cooling apparatus. Temperature levels are pre-determined by the requirements of each kind of perishable cargo.

As cargo is swung into place and stowed by longshoremen, the strictest precautions must be taken against shifting during rough weather. Listing, dangerous to ship and passengers, can result from two causes directly laid to loading—improper distribution of cargo; shifting of cargo during rough weather. The first cause is eliminated by proper loading at the pier, and the second is counteracted by correct stowage.

Simple devices are used to keep cargo in place. Carpenters make bulky cargoes solid. On top of the lower tiers of freight, "dunnage" (wood planking) is laid down as a flooring upon which the next tier of freight is stowed. Between the empty spaces of articles are placed blocks of wood ("chocking") so that empty places are completely filled and each tier of freight becomes one solid mass. Freight such as barrel goods, rolls of paper, newsprint, and roofing are stowed in "head-up" position, which prevents sliding and acts as "dunnage" for other material.

Safeguarding ship and cargo by proper stowage does not end the precautions against accident. There is ever present the fire hazard, and against this most dangerous of threats to safety the modern cargo ship has arrayed a formidable variety of equipment.

The most effective method of fighting such a fire today is by use of carbon dioxide. After closing all hold ventilators, the gas valves are opened from the engine room or the bridge and the carbon dioxide pours into the hold, smothering the fire.

THIS efficient 20th Century transportation of cargo by water is essential to the general good living of a highly industrialized society. Many luxuries of the past have become household articles today because of the ingenuity of modern transportation.

Celluloid for Hollywood film, iron for gas ranges, brass for faucets, porcelain for electric insulation, wire filaments for the radio tube, and constant supplies of fresh foods from the far corners of the earth—all these are the rewards of invention, modern water transportation, and the ingenuity displayed in handling mass freight shipments.

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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D. H. KILLEFFER
Chemical Engineer

Making Money Out of Roads

If a road carries 700 vehicles per day, how much revenue will it yield in gasoline taxes alone? The sum is surprising. If the drivers get 15 miles to the gallon (which most of them do not) and the gasoline tax averages 5 cents per gallon (which it does—at least), then the 700 cars a day will burn a little less than 17,000 gallons per mile of road per year, and the income from gasoline taxes will amount to about 850 dollars per mile.—*Highway Research Abstracts.*

Pipe-Line Tracer

An unskilled person can operate a new radio pipe-line detector which has been designed by Engineering Laboratories, Inc. With this instrument an underground line can be traced throughout its length. The receiving unit, which is shown in accompanying illustrations, comes complete with ear phones and weighs but seven pounds. A transmitter complete with batteries, two spears, and the necessary wiring, weighs but 10 pounds.

An alternating current is caused to flow in the pipe line by attaching the transmitter, which is in effect an alternating current generator, to the pipe line at some point where it is known or where some connections

Following a buried pipe line

Checking location of a pipe line

are visible and to a ground connection placed at some distance from the pipe line at right angles thereto. Current will, therefore, flow between the pipe line and the ground connection.

The receiver is a loop which picks up by induction the alternating current pulses when the loop is held in the proper relation to the pipe line. The maximum signal is received by the loop when its plane is perpendicular to the surface of the pipe. Therefore, it is possible to walk holding the loop in such a manner that it hangs down at right angles to the ground and thus to follow the pipe line indefinitely. When the loop is removed from the vicinity of the pipe line the signal naturally diminishes in strength. An amplifier is enclosed within the housing of the receiver to increase sensitivity.

Explosives from Manna

The manna which miraculously fed the children of Israel in the wilderness contains mannitol, an alcohol which is being synthesized in large quantities from corn sugar. Quite different from its original use is the modern application of nitrated mannitol as a safer explosive for use in blasting caps. Detonators containing hexanitromannitol are less sensitive to impact and friction than those containing other explosives.—*D. H. K.*

Portable Hardness Tester

A pocket-size, indicating, hardness tester, which has a direct reading dial and therefore requires no microscopes or calculations, has been developed by The Shore Instrument and Manufacturing Company, Inc. It is just six inches long and weighs one pound. The test point is a diamond-pointed hammer and the instrument has a new and improved clutch mechanism.

In making hardness tests, the instrument, shown in an accompanying illustration, is placed on the work in an upright position. The small button on top is pressed down and released. This completes the test, for the operation is entirely automatic, the indicating pointer finally coming to rest at the proper hardness number. Suitable attachments are supplied for using this tester on small objects which should be held in vises

Hardness tester in use

and also when it is desirable to make several tests on the face of a single piece of metal. The instrument comes in a small carrying case together with one hard and one soft master block for checking purposes.

Rayon Spinnerets

THE tiny orifices through which viscose is squirted to form rayon are ordinarily minute holes in platinum fittings. The reasons for the selection of this precious metal have been the ease with which holes of the proper size and shape could be made in it and its extraordinary resistance to corrosive materials used in the process. Recently the Japanese have succeeded in making spinnerets of glass which are much cheaper than those of platinum. The method consists of casting glass, in an atmosphere free from oxygen, around minute filaments of an alloy of iron and nickel which has the same coefficient of expansion as that of the glass, and subsequently dissolving out the metal with acid.—*D. H. K.*

Unique Electrically Recording Foucault Pendulum

IN an unoccupied elevator shaft at Mundelein College for Women, Chicago, a Foucault pendulum is being installed, by which rotation of the earth on its axis may be demonstrated and measured. Swinging nine stories, the pendulum is 120 feet long, the longest of its kind in existence and the only one of its kind, so far as is known, to have its movements recorded by an electric spark.

The suspension consists of two cylinders at right angles, rolling on flat surfaces. It is a device credited to Alaeine Cummings Longdon, of Knox College. The pendulum ball, which swings in the pit 120 feet below the suspension, is supported by wires from the upper cylinder. The contact surfaces are hardened and polished, resulting in very low friction.

Recording of the azimuth of the swing is by means of a spark discharge which punctures a coated paper disk, eight inches in diameter, on a suitable table below the pendulum. The table holding the paper disk

The recording Foucault pendulum

is made of hard rubber, 12 inches in diameter, supported by a tripod casting. A brass ring about 8.5 inches in diameter is inlaid in the top surface and is connected to a terminal below.

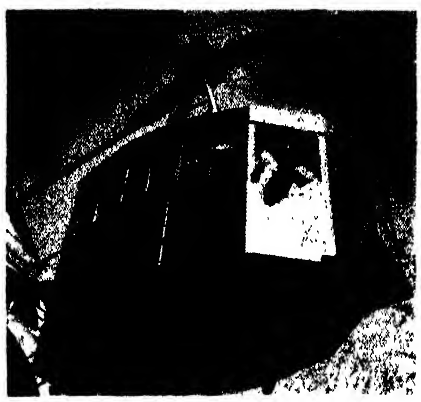
A high voltage transformer is connected between this terminal and the ground. Thus as the pendulum swings across the ring, a spark jumps between the ring and a platinum point on the ball. The coated paper on the ring is thus marked by the spark flashing through it. The brass ring is graduated in degrees to read the angular position of the points on the coated paper.

NOT OPINION

"IT is research, it is science, that has put success on a foundation of fact, not opinion."—E. R. Weidlein, Director, Mellon Institute.

New Hampshire Aerial Tramway

RECENTLY completed in the mountains of New Hampshire was the first project of its kind in North America, when the American Steel & Wire Company, subsidiary of United States Steel Corporation, put the finishing touches on an aerial passenger tramway constructed for the New Hampshire Aerial Tramway Commission. The project provides a safe, thrilling ride up the side of Cannon Mountain, near Franconia, New Hampshire, for the thousands of tourists, sightseers, and winter sports enthusiasts who visit New Hampshire annually.

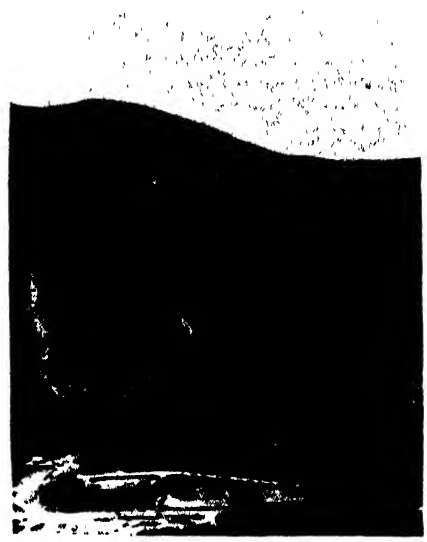


One of the two new tramway cars that carry passengers to the top of Cannon Mountain in New Hampshire

The cableway consists of two cars suspended from cables supported by steel towers. The cars are pulled 40 feet above the tree tops by means of a traction rope, controlled by machinery located at the Valley Station of the carrier, and pass each other at the half-way mark, one tram being at the Valley Station while the other is at the summit.

One of the outstanding advantages to be derived from the new project is the opportunity which will be afforded for an unsurpassed view of the surrounding countryside from the top of Cannon Mountain. The peak is over 4000 feet above sea level and other mountains and valleys for many miles in all directions are visible. The tramway makes the ascent in approximately 5½ minutes, whereas formerly a two-hour climb up a tortuous trail was necessary to attain the summit.

Included in the construction are five distinct safety features, including a patented braking device which prevents slippage in case the traction rope breaks; a special swing dampener, which operates on the principle of an automobile shock absorber and neutralizes swing of the cars; automatic stopping of the cars in case of accident to the operator; speed control; and an auxiliary traction rope for raising or lowering the trams to either the Valley or Mountain Station in case of failure of the regular rope. In addition, an auxiliary power plant is provided in the event of interruption of the regular power supply, besides many other features which are designed to eliminate accidents and discomfort to the passengers.



Arrow points to one of tramway supporting towers. Note that scenic beauty of the spot is not marred

The cars are dodecagonal, or twelve-sided, with windows in each side made of a non-brittle substance similar to that used in airplanes. Twenty-seven passengers and one attendant can be accommodated each trip and a total of 225 persons can be transported each way in an hour's time.

The cars travel at a normal speed of 1000 feet per minute, or at approximately the same rate as modern, high-speed passenger elevators in our skyscrapers. The length of cables between landing points is 5410 feet, or slightly over a mile, and the difference in elevation between the Mountain and Valley Stations is 2007 feet.

Marine Studio Design

IN our article on the new aquarium at Marineland, Florida, published in our June issue, lack of space caused us to omit mention of some of those concerned with the design of Marine Studios.

The design for the shape of the tanks was recommended by Fred Waller, president of Courier Productions, Inc., and other technical motion picture experts, following conferences by them with executives of Marine Studios. Mr. M. F. Hasbrouck, president of the Hasbrouck Company, Inc., New York City, developed the structural design of the tanks, using the shape recommended to him, after consultations with Gilbert Fish, consulting engineer who specializes in welding. The architectural design of the cor-

ridors around the aquarium hull was developed by two architects, John Walter Wood of New York and Frederick A. Henderich of St. Augustine.

Radiator Paint

THE time for painting household radiators usually being in the autumn, it is well to point out once more that the color of paints used on these radiators has no bearing whatsoever on the amount of fuel required to heat a given room or building. It is true that a black or dark radiator will emit more heat per square foot of surface than will a radiator painted a lighter color. But to produce a given amount of heat for any given interior space, the same amount of coal must be burned regardless of the color of the radiator.

It may be well to point out another fact emphasized years ago by the U. S. Bureau of Standards. This is that the flow of heat from radiators is better with an ordinary pigment paint than when one with a metallic pigment is used. Here again the amount of fuel will not be affected by the type of paint when a given amount of heat is desired.

Atom "Chips"

WHEN a housewife burns her finger, how much "nerve current" does the digit need to tell her brain how much it hurts? Westinghouse research engineers have developed a vacuum tube so supersensitive that it can measure the tiny current associated with nerve impulses, count the "chips" knocked off atoms by cosmic rays, and determine the acidity or alkalinity of blood. Known only as "RH-507," the tube may help reckon the earth's age by detecting radioactivity in rock.

High Nicotine Tobacco

NICOTINE, a valuable insecticide, is produced in the United States principally from the waste of factories where tobacco is prepared for smoking. Since nicotine is thus a by-product, American plant breeders have directed their attention toward producing leaves of superior smoking quality. Recently word came from Germany to the effect that tobacco plants containing an average of 8 to 10 percent nicotine are being bred for the purpose of supplying the alkaloid and that occasional plants contain as much as 16 percent of it. These percentages are several times as high as those in ordinary smoking tobaccos and compare with 2 to 3 percent nicotine in American cigarette tobacco. Obviously one might not find this tobacco pleasant to smoke.—*D. H. K.*

FREIGHT

FOR each pound of coal consumed, the railroads in 1937 hauled 8⅗ tons of freight and equipment one mile, the best record in fuel efficiency ever attained by them.

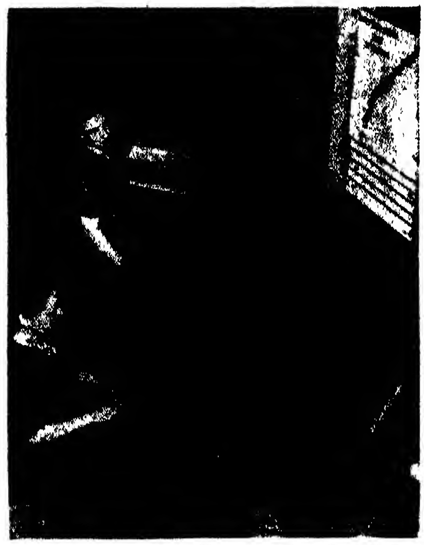
96 Messages Over One Pair of Wires

A NEW development in communication, making possible the sending of 96 telegraphic messages in one direction over a single circuit simultaneously has been demonstrated by Western Union Telegraph Company engineers. The system is now in commercial operation over Western Union circuits between New York and the following cities: Chicago, Washington, Atlanta, and Buffalo. It will eventually be extended throughout the country.

The new system utilizes a tone generator from the recently invented Hammond electric organ. This instrument, introduced about two years ago, reduced the pipe organ to a space no larger than that occupied by a grand piano by eliminating all pipes and reeds in favor of electrical impulses. Depressing a key on the Hammond console generates a minute electrical current of a given frequency which, carried into a tone cabinet, becomes the musical note corresponding to that frequency. Thus the key which sets up a frequency of 440 cycles is A above middle C on the piano keyboard and produces that note from the tone cabinet.

Communication engineers, hearing the Hammond in its legitimate rôle of organ, began thinking of it in terms of their business. They knew that multiple messages could be sent over a single circuit on different tone pitches. And the Hammond, operating on synchronous motors, offered a ready means of furnishing numerous pitches.

They experimented, found that by separating these pitches by 300 cycles they could put 22 on a single circuit. But each of these pitches can carry a number of messages by methods previously used by Western Union, with the result that a total of 96 messages in one direction is made possible. Twelve of the 22 frequencies are now in use, and the others are ready to take care of future business growth.



In a demonstration of the new telegraph system described, an electric organ, *background*, supplied tones

Tone generator of Hammond organ, *left*, and of telegraph equipment, *right*

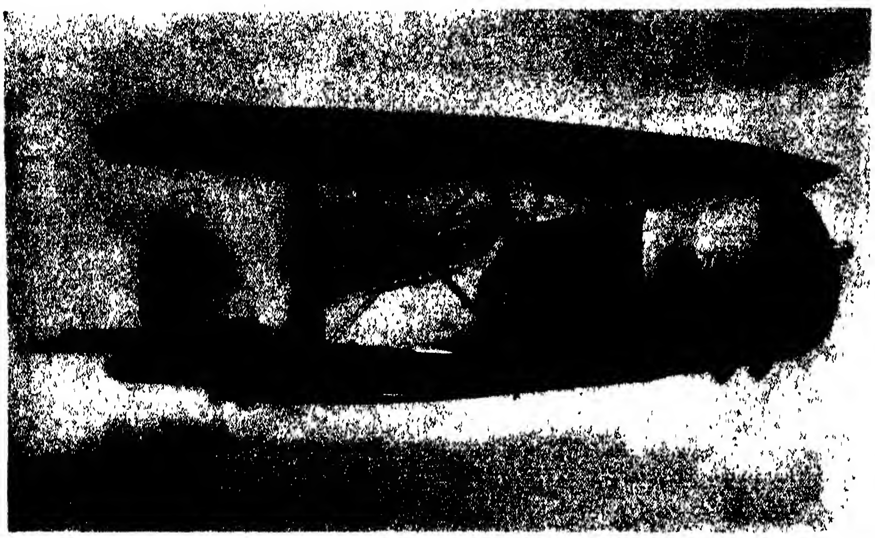
Stamp-Pad Ink

A STAMP-PAD ink, recently developed by C. E. Waters, of the National Bureau of Standards' Chemistry Division, penetrates most kinds of paper so quickly that there is little or no blurring of the impressions when they are rubbed with the fingertips immediately after they are made.

Duration of Life in Prehistoric Man

THE life of fossil man was short. Of 187 skeletons of determinable age recently examined by Dr. Henry V. Vallois, 55 percent Neanderthal, 34.3 percent upper paleolithic and 37 percent mesolithic subjects died before reaching the age of 20 years; while of the remainder, the majority, 40 percent Neanderthal, 53 percent upper paleolithic and 58.5 mesolithic, died between 20 and 40 years. Of the remaining sixteen, 5, 10.8, and 1.5 percent respectively died between 40 and 50 years, while only three survived the age of 50 years. Yet even these three had not attained true old age, as important sutures of the cranium were still not closed.

Notwithstanding defective evidence, there would appear to be a marked increase in the duration of life in the Bronze Age and among the Egyptians of the Roman period. In the fossil groups, man appears to have lived longer than woman. Especially below the age of 40 is feminine mortality



The Curtiss scout bomber, SBC-4

higher. As regards the cause of the early mortality, so far from civilization having shortened the natural span of life by "dysharmonics" as Metchnikoff thought, it appears to have lengthened it.—*Nature* (London).

Two Engines or Four?

THE Douglas DC-4 has gone through its tests with flying colors, but no orders have been placed for it as yet. The Boeing Stratoliner, nearing completion, is likely to be an excellent ship. Both are four-engined aircraft.

Now Curtiss-Wright challenges the theory that it is necessary to build four-engined transports like the DC-4 and the Boeing Stratoliner, and is building a slightly smaller craft, with only two engines. But each of these two engines will be of 1500 horsepower and the ceiling *on one engine only* will be 14,000 feet. The ship will have a cruising speed of over 200 miles an hour; the cabin will be supercharged to an equivalent altitude of some 12,000 feet so that flight at 20,000 feet will cause passengers not the slightest inconvenience.

For the twin-engined ship, the following advantages are claimed: lesser initial expense; lesser operating expense; lesser complexity. The designers of the twin-engined plane say that they will come very near to the pay-load capacity of the larger four-engined craft, with the possibility of much more economical operation.

Nothing will settle the argument except actual operation, but it is gratifying to see real competition between the various builders. At one time it looked as though Douglas, receiving a co-operative order from the five major airlines, would dominate the field of transport equipment. Competition is far more likely to aid progress than would a monopolization of the field by any one builder, however experienced and however skilled in the construction of these commercial giants of the air.—*A. K.*

Scout Bomber

WE have heard so much of the flying fortresses, bomber-battleships of the air, that we are prone to think of all bombers as being huge multi-engined affairs. But the Navy has to think of smaller craft which can be flown off the decks of the aircraft carriers—ships which can act as scouts as well as bombers. Therefore, Curtiss-Wright is building a whole series of relatively small single-engined scout bombers for the Navy. They are termed SBC-4, signifying scout bomber, Curtiss type 400.

The new ships are powered with 1000-horsepower single-row Wright nine-cylinder Cyclones. They are biplanes, so that the wing area may be concentrated in the relatively small dimensions required for aircraft carrier duty, and to give high maneuverability. Even though the SBC-4 is a biplane, it is exceedingly clean. The photograph indicates how snugly the landing gear rests within the fuselage, the small number of wires, the beautifully streamlined end struts, the enclosed transparent cockpit, and the smooth lines of the engine cowling.—*A. K.*

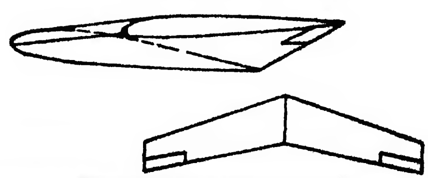
A Unique Tailless Design

SEVERAL readers have asked for information on the "Bumblebee" which James B. Taylor, Jr. has been testing recently. The Bumblebee is unique because it is not only tailless but is also without sweepback; many aerodynamic questions arise therefrom.

First of all: How is static longitudinal stability attained? In the entirely conventional machine static longitudinal stability is attained by the use of horizontal tail surfaces disposed at some distance from the center of gravity, and forming a negative dihedral with the main wing. In the tailless airplane the wing tips are turned up at the trailing edge so that the equivalent of the horizontal tail surfaces is provided. How, then, is static longitudinal stability provided in the Bumblebee? The conjecture is that such stability is secured by the special design of the wing itself. A wing with a pronounced turn-up of the trailing edge gives stability in itself although at the expense of reduction in maximum lift and in efficiency of the airfoil. Of course the Bumblebee has the compensating aerodynamic features of no horizontal tail surfaces and no long fuselage. Only refined wind-tunnel testing and careful calculations can determine whether there is over-all aerodynamic loss or gain in this novel design.

Besides the static longitudinal stability, a good airplane should have dynamic stability. In the conventional machine this is obtained by the "damping" of the horizontal tail surfaces, and such damping depends largely on the distance of the tail surfaces from the center of gravity. In the Bumblebee, "damping" can come only from the wing itself, and may not be quite large enough. Without sufficient "damping" a machine may be stable, but once disturbed may oscillate or pitch up and down for quite a long time. The mechanical analogy is that of a strong spring carrying a suspended weight. Without being immersed in oil, let us say, the spring is undamped and when the weight is pulled down it may subsequently oscillate up and down for a long time before coming to rest.

In a conventional plane, *above*, the tail surfaces form a negative angle. In the tailless plane the same stabilizing effect is obtained by the turned up wing tips as shown below



The tailless "Bumblebee," described in the text and drawings

Again, in the conventional machine directional stability is secured by the use of vertical tail surfaces (fin and rudder) disposed a long way from the center of gravity. In the Bumblebee, the vertical surfaces are naturally quite close to the center of gravity, but there are (as our photograph shows) four vertical surfaces, and the propeller itself acts as a vertical fin. Thus adequate directional stability is probably attained in spite of the small leverage of the vertical tail surfaces.

Steering is no doubt achieved by using the vertical surfaces at the tips of the wing as drag elements. If the pilot wishes to turn to the right, he displaces the right rudder *only*, introducing more drag at the right wing tip. If he wishes to turn to the left he displaces the left wing tip.

Long flaps run along the whole length of the wing, with auxiliary or trimmer surfaces behind them. Simultaneous depressing or raising of the flaps on either side gives elevator action; raising the flap on one side and depressing the flap on the other side should give aileron or lateral control.

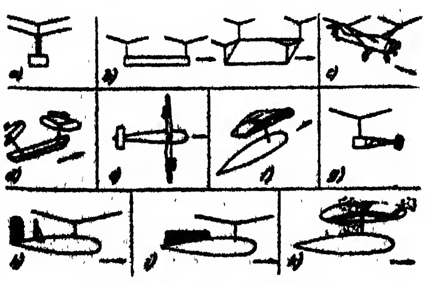
The craft is a pusher type with the 95-horsepower engine and propeller in the rear. Mr. Taylor points out that if two engines were fitted at the rear with a wide interval between the propellers a machine gunner would be able to shoot directly back, unhampered by the tail—a distinct military advantage. The machine illustrated on the opposite page is a two place cabin model and the top speed is estimated at 120 miles an hour.—*A. K.*

HELICOPTERS

THERE is real promise of a revival of interest in rotary-airfoil craft. The Army Air Corps, artillery experts, and other military authorities have become convinced that the Autogiro has a unique rôle to play in military operations, and a number of Autogiros are under construction by the Kellett Autogiro Company, *not* as experimental machines but as additions to the specialized equipment of the Army. From Long Island City, New York, there come reports of a small helicopter, being built to the designs of Dr. De Bothezat, which is to give us a small, high-speed machine of particular utility for warfare. In Germany the Focke Helicopter has broken all previous helicopter records.

In an article in *Luftwissen*, Professor Focke describes his remarkable craft and in so doing presents a very fine picture of the general principles and difficulties of the helicopter. A study of Professor Focke's article will be of value to all those interested in that final mastery of the air which calls for vertical ascent, vertical descent, and the ability to hover at will.

Professor Focke spent five years in theoretical research, in experiments in the wind tunnel, and in flights with a "captive" helicopter before securing his final excellent results.



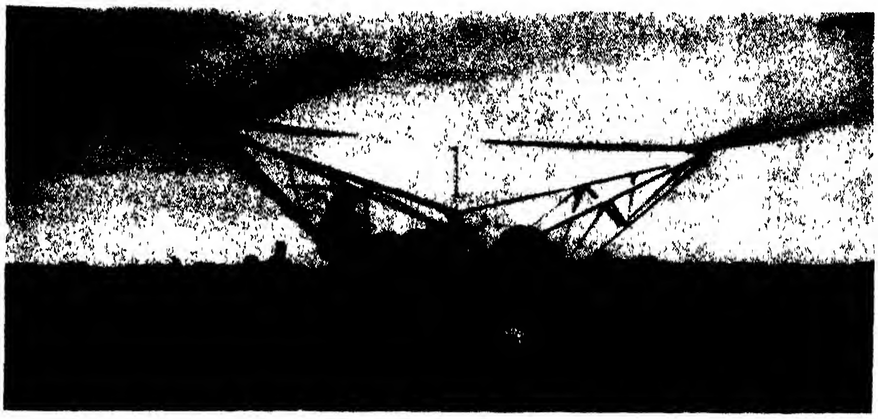
Proposed helicopter ideas

The lifting airscrew, in order to provide sufficient lift per horsepower, must have a large diameter and rotate rather slowly. The necessity for a large, slow airscrew has long been recognized, but such an airscrew introduces a very large torque or unbalanced moment which must be eliminated if the fuselage and the pilot are not to turn dizzily in space. Several plans have been proposed to this end and are illustrated in an accompanying drawing. These ideas may be classified as follows;

a. Two propellers mounted on a common vertical shaft, and rotating in opposite directions. Professor Focke rejected this arrangement because interference between the screws reduces the lift, and also makes the vertical descent without power less effective.

b. Two screws placed one behind the other, or four screws arranged at the corners of a square. Here the criticism is that the rear propeller is powerfully influenced by the wash of the front propeller, with adverse effects on stability.

c. Two airscrews placed on opposite sides of the fuselage. This has been tried by Berliner, and has been adopted by Professor Focke.



Front view of the Focke helicopter with lifting screws in rotation

d. Screws rotating in the *same* direction; skilful inclination of the axes eliminates all unbalanced moments.

e. A single large screw on whose blades are located small propellers. Since the small propellers provide the drive, there is no reaction torque. Experimental work has shown that this type, instead of achieving simplicity, produces enormous complication.

f. A screw with flapping blades so that rolling and pitching moments cannot be transmitted to the fuselage. Flapping blades may be very useful in the helicopter art but they do not eliminate the rotation torque.

g. A single airscrew for lift and another smaller propeller mounted on outriggers far at the rear, providing a lateral thrust to counteract the turning moment of the main airscrew. A long transmission to the rear is necessary and power is wasted in the production of side thrust.

h. A variation of *g*.

i. A vane is mounted in the slipstream of the main airscrew but assumes formidable proportions.

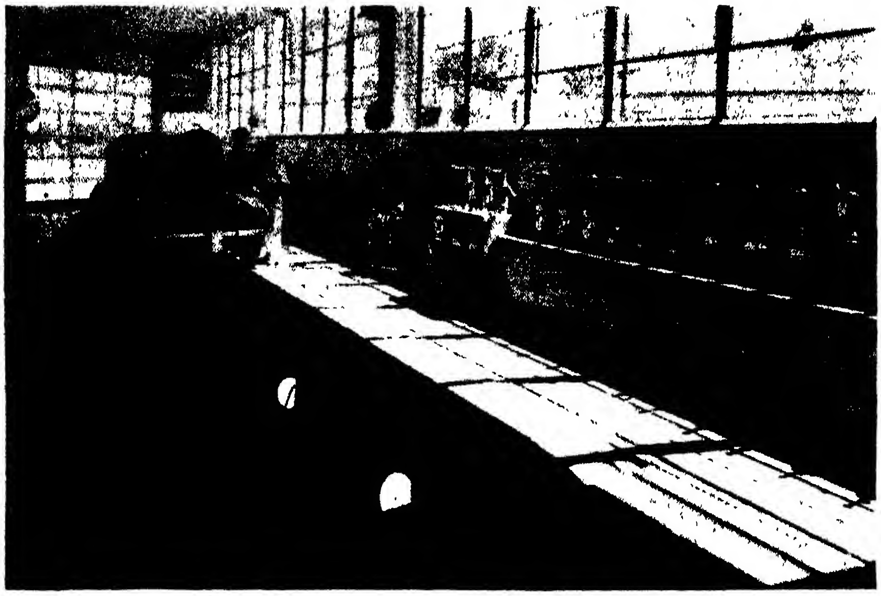
k. Jets acting by reaction at the ends of the lifting blades may be dismissed as in the realm of the fantastic.

The Focke helicopter in flight

After passing all these schemes in review, Focke decided on the two screws placed on opposite sides of the fuselage, the rotating blades of which can be varied in pitch when they pass certain points. This we presume is analogous to the control introduced by E. Burke Wilford in his Gyroplane, and is a promising method. To secure safety in the event of power-plant failure the pitch of the blades can be rapidly reversed so that the aircraft descends as a windmill without power. Three blades on each screw of moderate diameter were developed by intensive wind-tunnel research. The diameter was rather smaller than one expects in a helicopter. No doubt some degree of climb was sacrificed so as to secure reasonable forward speed. There is a very delicate problem here for the aeronautical designer. The temptation to increase the diameter and thus secure more lift is apt to lead to an inadequate forward speed.

The mechanical difficulties in the bevel-gear drive from the engine mounted at the forward end of the fuselage were surmounted by careful design and test. A friction coupling was included in the transmission system. A small airscrew mounted at the nose of the fuselage serves to cool the motor when vertical ascent, descent, or hovering fails to give sufficient cooling air-stream. In all other respects Focke followed conventional airplane practice.

The actual figures of performance have been checked by representatives of the International Federation of Aeronautics. With a machine carrying a single occupant, and a small amount of fuel (this is perfectly legitimate, particularly as in a small helicopter the weight of the transmission is much more of a handicap than it would be in a much larger machine), with a gross weight of 950 kilograms or about 2190 pounds, the figures are: Climb at the rate



Ten minutes on this conveyor and an automobile is completely serviced

of about 12 feet a second; altitude attained 7500 feet; endurance 1 hour 20 minutes; distance 67 miles; speed 74 miles an hour.

There is not the slightest doubt that all previous helicopter records have been far surpassed.—*A. K.*

Civil Aeronautics Authority

ESTABLISHMENT of a Civil Aviation Commission was recommended by the Federal Aviation Commission two or three years ago but was opposed by the President and by several government departments. Now the passage of the McCarran Bill in the Senate and the Lea Bill in the House has resulted in a conference report and the final passage of an Act which will establish an independent Civil Aeronautics Authority.

The Civil Aeronautics Authority will include five members at $12,000 per annum each; an Administrator at the same salary; and a Safety Board of three well-paid members, besides several secretaries and other officials. It will be expensive, but provided the Authority is on the whole non-partisan, and provided it includes men well versed in various branches of aviation, such as air transport, miscellaneous flying, airports and airways, and so on, the expense will be well worth while. At least that is the opinion of well-informed aviation men, based on the following facts:

It will concentrate the authority of three bodies—the I.C.C., the Post Office Department, and the Bureau of Air Commerce—in one body of a semi-judicial, semi-administrative character, and it is always better to be regulated by one Board than by three.

It will remove the fixing of mail rates from the Post Office Department, which was both the customer and the arbiter.

It will make recording of aircraft ownership a matter of one record, thus permitting mortgages to be made on aircraft and the airlines to borrow money on aircraft trust certificates analogous to railroad equipment certificates.

It will further aviation safety and make reporting of accidents more of a public matter.

It will permit the Federal Government to take over the regulation of flying in all phases of inter-state commerce, and by enlargement of this sphere will avoid the duplication of licensing effort by Federal and State authorities.

The aircraft industry has suffered so much and so long at the hands of the Government that it is almost afraid to voice these hopes; on the whole, however, confidence outweighs fear of the new Authority.—*A. K.*

Conveyor Lubrication for Motor Cars

FIFTY minutes' work in ten minutes' time on automobiles riding the new lubrication conveyor at the service center and store just completed by The Austin Company for an auto supply company in Detroit, is proving the answer to many an impatient motorist's prayer.

Five to seven men are on the job as cars travel on a continuous conveyor above the spacious 53-foot pit where recessed spotlights and hose carrying special lubricants for every motor maintenance need have been installed. If an oil change is necessary, the old oil is drawn out of the crankcase under a powerful vacuum, which takes with it all the sludge, sediment, or other foreign matter and leaves the crankcase vacuum cleaned. Old grease is drawn out by a similar vacuum suction method, after preheating when cold weather makes this necessary. Transmission and differential grease is metered into the car under pressure direct from sealed drums, to assure accurate measure and proper grade.

Before the ten-minute conveyor ride is up, tires have been checked and inflated to the desired air pressure; battery tested and filled to the proper level; floor mats brushed or vacuum cleaned; all glass polished; and door locks and hinges treated with dry oil, which provides easy operation without danger of motorists soiling gloves or clothes.

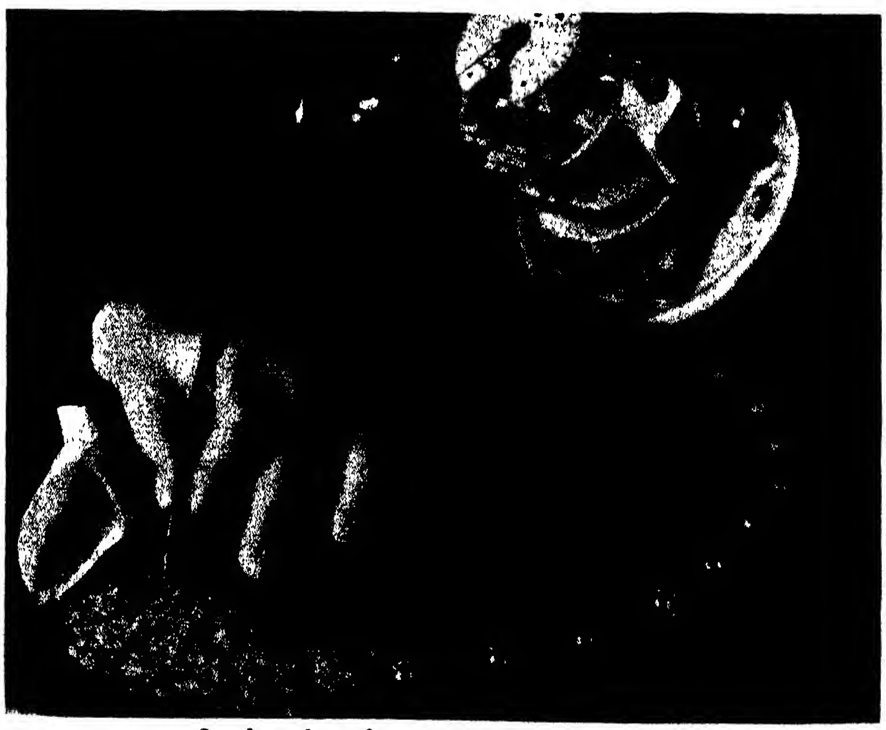
ROLLING POWER

A STANDARD Pullman car generates for its own use enough electricity to supply four ordinary homes.

Jewels in the Cellar

JUST 50 years ago in May the electric meter was invented by O. B. Shallenberger of the Westinghouse Company. Today, with an annual national power production of 110,000,000,000 kilowatts, 237 different types of meters, relays, instruments, and electronic devices chiefly used in measuring and controlling electricity are made by that company.

The house meter of the familiar round type usually placed in the cellar, and which was developed by Dr. Frank Conrad, is built with the precision of a fine watch. For the



Jewels such as these are found in many cellars

bearings alone, the Meter Division of the above-named company uses about 2,000,000 sapphire jewels annually. Our accompanying illustration shows a quantity of these jewels cut in tiny disk shape and drilled ready for use.

Printing Type from Resins

SYNTHETIC resins are being used in Germany for the molding of type to save metals. The resin used is a polystyrol which can be cast and re-melted after use. Among the advantages claimed are lightness, and hence low transportation cost, and avoidance of possible lead poisoning of printers. —*D. H. K.*

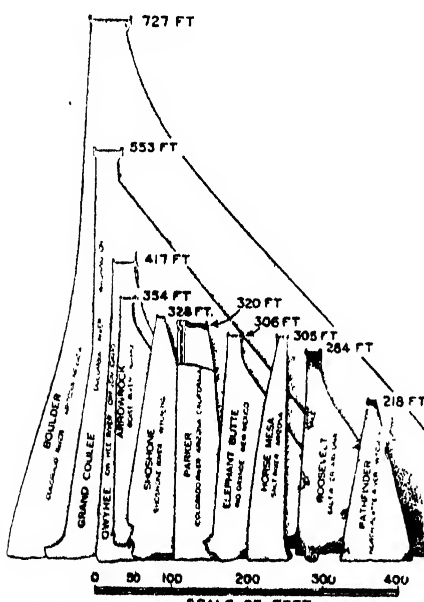
Mental Disease Not Increasing

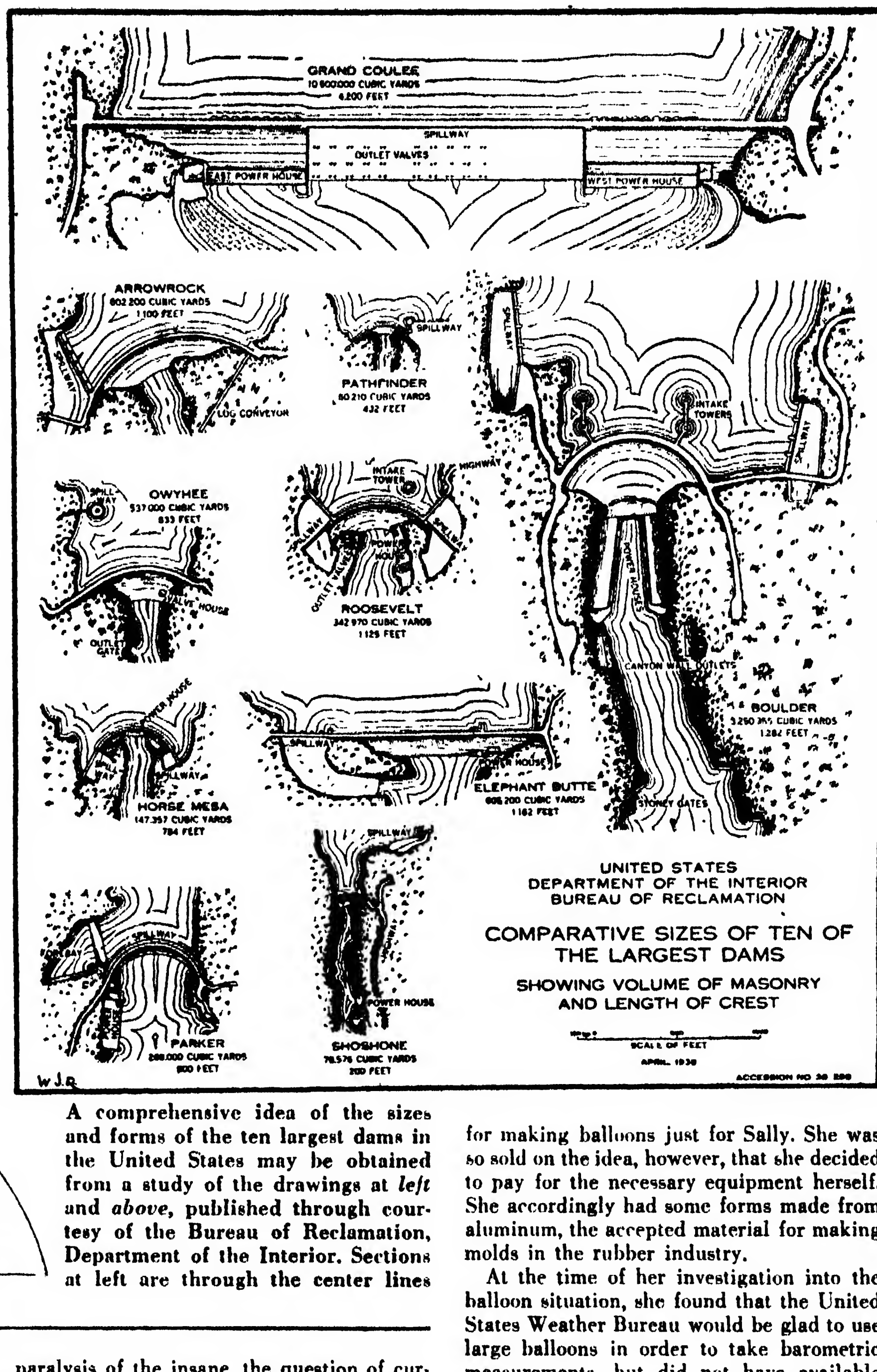
MENTAL disease is not increasing and the outlook for recovery of the mentally ill is hopeful. This is the opinion of Dr. Richard H. Hutchings of Utica, New York, State Hospital, who will be president of the American Psychiatric Association for the coming year.

The undoubtedly great increase in recent years of the number of patients in mental hospitals is not a sign, in Dr. Hutchings' opinion, that mental disease is increasing. It means that mental disease is being discovered in its milder forms and that patients are going into hospitals, many of them voluntarily, for treatment of these mild forms of mental ill health.

The present popularity of the mental hospital, Dr. Hutchings said, is a phenomenon of modern times. About one fifth of the patients at Utica State Hospital have committed themselves, a thing which would have been unknown 40 years ago when Dr. Hutchings first entered psychiatric practice. At that time, patients usually had to be brought to the hospital by the sheriff.

Progress in methods of treating mental disease, and in preventing it through mental hygiene in schools and colleges, makes the outlook on the whole problem today very hopeful. In the case of paresis or general paralysis of the insane, the question of curing a patient never was considered 40 years ago. The only question then was how long the patient would live. Now, with the use of fever treatment and arsenicals, about one third of such patients recover and another third are able to leave the hospital and find gainful occupation.—*Science Service.*





A comprehensive idea of the sizes and forms of the ten largest dams in the United States may be obtained from a study of the drawings at *left* and *above*, published through courtesy of the Bureau of Reclamation, Department of the Interior. Sections at left are through the center lines

Sally's Balloons for the Navy

SALLY RAND, who occasionally lectures to advertising clubs on the subject entitled, "The Value of White Space," decided to change her fan dance into something else. She chose a bubble dance, and wanted to use huge balloons in this act. These balloons were to be inflated up to 60 inches, which is her height, and they were to be of the proper density.

There was no rubber manufacturer in the country who made toy balloons of such a size and no one cared to invest in the equipment for making balloons just for Sally. She was so sold on the idea, however, that she decided to pay for the necessary equipment herself. She accordingly had some forms made from aluminum, the accepted material for making molds in the rubber industry.

At the time of her investigation into the balloon situation, she found that the United States Weather Bureau would be glad to use large balloons in order to take barometric measurements, but did not have available the funds which would cover the cost of making such large balloons.

The Navy also would like to use large balloons for airplane targets on the water. Sally now sells her balloons to both the Weather Bureau and the Navy, but refuses to sell the balloons to anyone else.

Horses and Mules Down

THE number of horses, including colts, on farms January 1, 1938, is estimated by the Bureau of Agricultural Economics at 11,163,000 head, a reduction of 282,000 head, or approximately 2.5 percent, from a year earlier. The reduction during 1937 was larger than during 1936.

Although the number of colts raised in 1937 was larger than in 1936, death losses of horses were unusually large in a number of states. The average value per head, January 1, 1938, was $90.83 compared with

$99.16 a year earlier and the total value of $1,013,960,000 was $121,000,000 smaller.

The number of mules on farms, January 1, 1938, was 4,477,000 head, a reduction of 94,000 head, or 2.1 percent, from a year earlier. The value per head of $122.43 was $7.50 lower than a year earlier and the total value of $593,898,000 was about $46,000,000 smaller.

Flatiron Thermostat Without Lag

THE efficiency of an electric flatiron with automatic heat control depends on the design of the heat controlling mechanism, usually called a "thermostat."

Should the heat transfer from soleplate to the thermostat be delayed, the action of the thermostat will lag behind the temperature changes which take place during ironing, and wide temperature fluctuations at the ironing surface are the result. This defect is especially dangerous when the iron is operated at the lower temperatures where delicate fabrics such as silks and rayons are ironed. These fabrics require even, moderate heat to save them from becoming brittle.

For better ironing

In order to correct the defects of the conventional thermostat, which depends on a secondary unit (a strip or plate of two metals of different expansion coefficients welded together) for its actions, the bimetal strip or plate has been abandoned by an inventor and the soleplate itself made the heat controlling member. In other words, the heat controlling member was put *directly* in contact with the goods to be ironed, without any detours.

The simple construction of the heat control is shown by the photograph. The minute expansion and contraction of soleplate "A" is multiplied by toggle lever "C" and member "B" which is made of metal of very much lower expansion coefficient than soleplate "A". The up and down movement of lever "C" actuates a make and break switch that is not shown in the photograph.

Saw Cuts With Electric Arc

AN electric arc saw that will cut iron, steel, any alloy metal, ferrous or non-ferrous, tungsten carbide as readily as low carbon steel, and yet leave the surface of the cut clean and smooth, is announced by Miller Electric Mfg. Company, under the trade name "Miller-Strobel" Electric Arc Saw. It is easy and safe to operate, due to the low voltage applied across the arc, and can be operated by anyone without special training. It cuts with equal efficiency, economy, and speed regardless of the hardness or analysis of the metal, and without changing the temper or destroying the structure of the metal. It is said to be more economical and faster than any other type of metal cutting.

High-speed metal cutter

While the illustration here shows a saw for cross cutting, it can be furnished in special models for slotting, turning, arc threading, arc milling, and arc turning. Mechanically, the sawing unit itself consists of a soft alloy steel blade provided with a multitude of small straight teeth on its circumference. This blade is V-belt driven at a high speed by an industrial type electric motor.

Cuts are made by means of a controlled electric arc that "leaps" ahead of the saw and brings the metal along kerf lines to a molten or plastic condition. The saw blade functions only to sweep the molten metal from between the kerf lines and as an electrode from which the heat generating arc "jumps" to the work. The blade itself does no cutting, as it is of soft alloy metal. Its real function is to give impulse to an oscillation of the current through a lengthening and shortening of the arc which stabilizes and directs the path of the arc to such an extent that side arcing is eliminated. The arc thus controlled travels in a path a few thousandths of an inch wider than the width of the blade. When cuts are completed the saw will be found to be cool.

To generate the arc between the saw and the work, a specially built welding transformer is used to provide a current of suitable voltage and amperage to melt the metal to be cut. This current is controlled so that it will cut metal of various thicknesses. Stacked metal is cut as easily as a solid piece of metal. The "Miller-Strobel" Electric Arc Saw is made in a range of models to handle different types of production.

DESTROYERS

WOOD is destroyed on land by six kinds of insects and one plant species. The plant is the shelf, or bracket, fungus; the insects are the dry-wood and damp-wood termites, the death-watch, the false death-watch, and the powder-post beetle, and, finally, the carpenter ant.

Train Speeds on Schedule

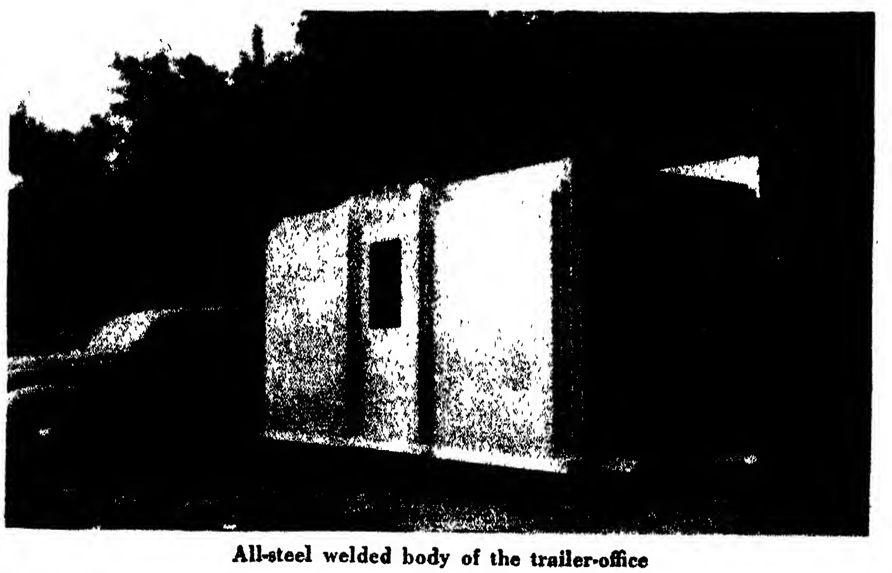
THERE are nearly 800 passenger train runs in the United States at speeds of 60 miles or more an hour. The fastest train run in the United States, start to stop, is 81.3 miles an hour, although some trains attain speeds over certain stretches of their runs of 90 to more than 100 miles an hour. Including all stops en route, the average speed of passenger trains operated in the United States in 1937 was 34.5 miles an hour. This average compares with 34 miles an hour in 1936.

The fastest long-distance freight train in the United States covers a run of 527 miles in 12 hours and 50 minutes, including stops. This is at the rate of 41.1 miles an hour. The average speed of freight trains, including all stops en route, was 16.1 miles an hour in 1937, compared with 11.1 miles an hour in 1922.

Welded Trailer-Office

"SORRY, but we do not have a single room left," a familiar statement by hotel clerks in Kansas, Oklahoma, or Texas during an oil boom, doesn't bother Mr. U. H. Hunt of Kansas City, in the least. For Mr. Hunt, welding contractor, literally takes his house and office with him. It can readily be moved about on a trailer.

The modernistic, all-steel building serves as office during the day and hotel at night. It is 16 feet long, 8 feet wide, and 8 feet 4



All-steel welded body of the trailer-office

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Modern Business

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Please mail me, without cost or obligation, a copy of "Forging Ahead in Business."

Name ....

Business Address ....

....

Position ....

inches high. The frame, walls, doors and window frames are all electrically welded with shielded arc equipment of The Lincoln Electric Company. In walls and ceiling, to insulate the structure, is two inches of cork. Inside, the finish is in plywood. Power for electrical appliances, when not otherwise available, is supplied by a 200-ampere gasoline-engine-driven Lincoln welder fitted with an oversize exciter.

The cost of building this portable arc-welded steel hotel and office, including material and labor, was no more than that of a house trailer.

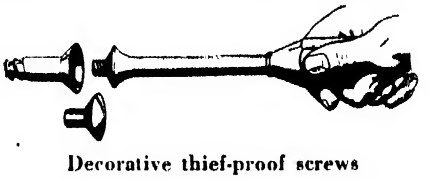
140,000 YEARS

ONCE every second for over four years, a silent mercury-type switch—a test sample of the type recently placed on the market by General Electric—noiselessly turned a lamp off and on. Early in June this switch had operated as much as it would have in ordinary household use during a period of 140,000 years.

Sightly Screws with Plastic Heads

ABOUT a year ago Mr. Granville Bradshaw, the well-known research engineer, invented the thief-proof screw in response to an appeal from railway and omnibus companies and hotel proprietors, who suffer considerable loss through the theft of various small fittings. These losses are estimated to amount to many thousands of pounds per annum.

In principle, the thief-proof screw, like most successful inventions, is a very simple one and consists of a cup-shaped head which



Decorative thief-proof screws

requires a special screw driver to insert the screw and a special one to remove it. Thus, the petty pilferer carrying a small screw driver or other useful implement could not remove the screws or the fittings.

It then became essential to find something to fill the hollow head in order to provide a more finished appearance, and Mr. Bradshaw tried literally hundreds of different materials, including metals, wood compositions, casein and, at last, cellulose acetate. With this he found that if it were made up into small domed cap pieces to fit the threaded hole in the screw head, a solution to the problem was at hand. Further experimenting with acetate showed that his original idea was correct and now it is possible to drive one of the plastic heads lightly into the screw after it is screwed home in the wood. The natural resiliency of cellulose acetate obviates any possible risk of fracture and it is soft enough to sink into the thread and so ensure a tight grip.

The new plastic-headed screw is infinitely preferable to a metal cap since it is obvious that the metal cap when driven home ruins the thread in the screw and makes it almost impossible to remove the screw without dam-

age to the surrounding parts. This trouble is, however, completely overcome by the use of the new plastic caps, which, although costing no more per gross than the metal caps cost per dozen, can be removed without much difficulty. Caps can be obtained to match any scheme of decoration. Thus there is no longer any need for work to be marred by rows of unsightly screw heads.—*Plastics*, London.

Electric Metal Etcher

An electric etcher for permanently marking on metal surfaces has been announced by the Ideal Commutator Dresser Company. Used in the same manner as an ordinary lead pencil, the etcher writes, prints, or marks on tools, gages, dies, and hard metal parts by burning the surface

Etching electrically

electrically. The permanent lettering stands out clearly and positively, eliminating mistakes and losses, confusion and improper assembly. The device operates rapidly, economically, and accurately. Two points are provided with the unit, one copper that may be sharpened for fine marking, the other a special alloy for ordinary marking. The depth of the mark is controlled by the speed at which the point is moved over the metal, and also by changing the Hi-Lo switch on the transformer.

Molasses Roads

Resins made from molasses may soon be used to bind road surfaces if experiments now in progress in India are successful. The method consists of resinifying molasses with coal tar and asphalt in the presence of acids. A combination occurs between the sugars of the molasses and the phenols contained in the asphalt and tar to yield a product insoluble in water which can be applied to the road as a liquid and which later solidifies. It is expected that the new compound will be cheaper than asphalt products now used.

The molasses is heated to free it from water and is then treated with 1 percent of dilute sulfuric acid. A mixture of asphalt and coal tar is similarly treated and the two mixed and heated together until the resin is formed.—*D. H. K.*

A Job For Lignin

Millions of Americans make daily use of shirts, sheets, paper, rayon fabrics, artificial leather, Cellophane, and Celluloid—all products of cellulose, the substance which forms the cell walls and fibers throughout the plant kingdom. But of cellu-

lose's almost inseparable botanical brother, lignin, most people are not even aware.

In fact, so elusive has lignin been that in almost 100 years of study, scientists have not been able to determine its chemical nature. What they have known is that lignin is a powerful cement which binds plant cells together. Aside from that function, lignin has been not only useless, but something of a nuisance in that it must be removed before white paper, rayon, and many of the other cellulose products can be produced; and a million tons a year of it (constituting part of the waste from pulping mills), have been polluting streams into which it is dumped, killing fish. Moreover, 15 million tons more, contained in four times that tonnage of waste wood, have been worthless.

Only now, after years of research, has the U. S. Forest Products laboratory at Madison, Wisconsin, discovered a means of ending this vast economic waste by qualifying lignin for inexpensive moldable, machinable plastics with possibilities which appear limitless.

> **HYDROPONICS**
>
> **DURING the first ten days of May on Wake Island's famous soilless farm, 33 pounds of tomatoes, 20 pounds of lettuce, 20 pounds of string beans, 15 pounds of squash, and 44 pounds of corn were harvested from the shallow water-filled trays in which the crops are grown.**

The striking advantage of the lignin plastic, which the laboratory has named Xylite, over its established competitor-plastics lies in its being a product of wood wastes that until now have had no economic value. It is, therefore, possible to produce it at a very low cost which Carlile P. Winslow, chief of the laboratory, estimates to be two to three cents a pound in bulk. Other types of plastics, which are already serving as substitutes for still more costly wood, metal, glass, and leather, cost very much more than Xylite. Thus, new spheres of usefulness, which cost prohibits present plastics from entering, are almost certain to be opened up. Adaptability of the new product to radio cabinets and table tops, floor tiling and wall paneling, bathroom scales, electrical insulators, auto instrument boards, and even bath tubs is foreseen by laboratory experts as the basis of a profitable industry.

The abundance of the raw materials for making such products is emphasized by Mr. Winslow when he says: "Lignin makes up 20 to 30 percent of the weight of the average plant stem. Billions of tons of it are present in the world at all times, and the supply renews itself indefinitely by natural growth."

Whereas the process of lignin wood-waste molding is patented, under the terms of the grant, any manufacturer has the right to use the process in making sawdust-base products. Although no manufacturer has availed himself of the rights as yet, it is expected that Xylite products will appear on the commercial market within the year.

Relative simplicity characterizes the new process. Into a heavy iron kettle, known as the digester, sawdust is shoveled, dilute acid is added, the digester closed, and the mix-

ture heated or "hydrolized." Change in the chemical nature of the sawdust converts part of the wood into sugar, so that when the digester is opened, what has been sawdust is found to be a mixture of dark syrup and powder. By draining off the syrup, placing the powder in molds of desired form and subjecting it to powerful hydraulic presses, it is possible to turn out disks, trays, knobs, handles, bowls, or sheets which may be machined by turning, sawing, or boring, much as hard rubber is handled. The products have a high glossy polish which needs no burnishing.

Although Xylite is an opaque ebony-colored product, which cannot be prepared in the transparent and light-colored types of some established plastics, it responds readily and attractively to surface finishes in any shade of enamel, paint, or lacquer. If a metallic tone is preferred, powdered metal sprinkled into the mold before it is filled with the plastic powder makes the metal a part of the completed product. If the effect of wood is desired, beautiful hard panels may be produced by similar use of figured veneers such as walnut, woven veneers, or appliquéd veneers, none of which will peel off. Similarly, decorative materials such as paper or cloth may be used.

Among the desirable qualities of Xylite are its high electrical resistivity, its water-proof qualities, its resistance to acid, and its warmth to the touch.

Simulated Neon Signs

Sign manufacturers have found an interesting new use for fluorescent paints. When a so-called neon sign is proposed, the manufacturer paints a miniature model of the sign with various colors of fluorescent paints serving in the place of the gas tubes that will be in the completed sign. This model, exhibited to the purchaser in a dark cabinet under the rays from ultra-violet lamps, gives a perfect imitation of the glowing sign as it will appear complete with its tubes.

Fly Spray

Insect sprays use huge quantities of pyrethrum flowers, a Japanese variety of chrysanthemum, as the source of the insecticide, pyrethrin. This insecticide has the advantage of being harmless to human beings but deadly to insects. Present disturbed conditions in Japan have seriously curtailed the world's supply of these unique flowers and a world-wide search has been made in an effort to find a climate and soil where they can be grown. Present indications are that the British colony of Kenya in southeast Africa provides ideal conditions for this plant and its culture is being undertaken there on a large scale.

Shortage of pyrethrin has also encouraged the search for synthetic materials of equal potency and safety. One of those recently announced as meeting the requirements is isobutyl undecylene amide. Investigations so far made suggest that this compound can replace pyrethrin from flowers in household insecticides.

These two attacks on the natural monopoly which Japan has held seem both to be successful.—*D. H. K.*

Conducted by JACOB DESCHIN

Action Picture Time

If you're aiming to get some action pictures, we hope you have done something about the matter by this time; if not, prepare to do so now before vacation time comes to an end. It is during these vacation months, when all the world is eager to be on the move, just for the pure animal fun of it, that you will have more rich opportunities for real action shots than at any other time of the year.

A lot of camera-toting people seem unaccountably timid about this whole business of action photography. Those who own cameras with top shutter speeds of 1/100th or 1/200th second are particularly dubious about getting any results, feeling that these top speeds limit their chances of stopping action. Haven't they tried now and then and haven't the results been distressingly fuzzy? So what? Leave the ultra dizzy subjects alone and aim for the possible.

One thing should be kept constantly in mind when taking action pictures: make your picture give the impression that your subject is really in action and is not stuck in space. Obviously, we know that the subject was moving when the shot was made, particularly when the subject is caught in mid-air. However, fact and impression do not always go hand in hand, and though we know the action to be a fact, yet somehow the "frozen" action in which every detail is dead sharp often fails to evoke in us the emotional truth necessary to make us feel that the subject was in action.

What it all comes down to, then, is this: reasonable show of movement or "fuzziness" is more often a help than a hindrance in achieving the all-important impression of movement. There is a limit beyond which, of course, it is ludicrous to go, and it is not advocated that a subject requiring 1/500th second to "freeze" may, for the purpose of conveying the feeling of action, be shot at 1/50th. Off-hand, we should say that in many cases a shutter speed of 1/200th or 1/300th may be sufficient. The picture will not be dead sharp but the subject will look alive and kicking (or flying).

Workers lacking the very high shutter speeds may also take comfort in the fact that the point of view with relation to the moving subject will alter considerably the shutter speed required. By taking the subject as it is moving toward or away from the camera, on a straight line with the lens, the required shutter speed may be as slow, relatively, as three times that required for the same subject moving parallel to the camera lens, while the diagonal point of view, which is the most pleasing, will call for a shutter speed twice as long. Another point to consider is the fact that the greater the relative distance from camera to subject the slower the shutter speed required.

The principal thing to consider is that stopping "dead" is more to be avoided than

Prize Winners in Our "Work" Competition

1ST The hand of a carpenter working on his new home furnished R. B. Stewart, Yellow Springs, Ohio, with the inspiration for this First Prize "Work" picture. Graflex camera, Defender XF Pan

2ND Symbolism by Louis A. Paige, of Utica, New York. Pick shadow was cast by a cardboard cutout placed three feet over the lunch box. Taken with a Feca camera on Super Plenachrome film

desired, however thrilling the prospect may sound, and that an impression of movement is preferable to a sharp image. Sharpness is not to be despised altogether, of course, but somewhere in the image let there be some slight fuzziness to satisfy the emotional sense that action has taken place. Those who see the picture afterward should not be required to take this fact for granted but must be made to feel that it is so.

PHOTOGRAPHY AT NEW YORK'S WORLD'S FAIR

WITH the New York World's Fair only a few months away, there is considerable discussion in photographic circles as to the possibility of an international photographic exhibit at the Fair. That such an exhibit is bound to be included seems to be taken for granted, the general opinion being that even if photography had not attained the remarkable popularity that it enjoys today, it has a rightful place in such a project as a World's Fair by reason alone of its century of achievement and service to humanity both in the arts and in the sciences.

To many it seems obvious that the responsibility for assembling an international exhibition of photography that will befit such a grand-scale venture as the World's Fair should fall upon the shoulders of an organization with experience in such exhibitions and enjoying contacts enabling it to gather the best the world has to offer. Frequent references are made to the Oval Table Society, Inc., until recently headed by Pirie MacDonald, Hon. F.R.P.S., and now presided over by Dr. Orrin Sage Wightman, A.R.P.S., as the organization best fitted for the undertaking. This is the society, it will be recalled, which recently brought together from many corners of the world the International Exhibition of Photography that attracted so much attention when shown at the American Fine Arts Society in New York.

But whether this organization or some other will be called to the task, the general opinion seems to be that an exhibition of international proportions is bound to be held and that the Fair would be incomplete without one.

FLASH CONTEST

THE Second Annual Kalart Synchro Sunlight Contest has been extended to Nov. 1, 1938, according to an announcement by the sponsors. The prizes total $250, with first prize of $100, second, $50, and third, $25. In addition there will be 15 other prizes amounting to $5 each. An entry form may be obtained by writing to the sponsors. Judges will include Willard Morgan, publisher of books on photography; Herbert C. McKay, F.R.P.S., well-known photographic technician and writer; and Kip Ross, Supervising Photographer, Associated Press.

INSPIRATION BOX

THE darkroom is a fine place for thinking up the swellest ideas, but if you don't put them down somewhere at once, nothing is easier than to forget them after you emerge into the open again. So set aside a box or other receptacle in the printing table drawer or elsewhere, and use it as a sort of "inspiration box" in which to drop

$225
IN PRIZES
for Amateur Photographers
Complete rules of the
Third Annual
SCIENTIFIC AMERICAN
Photography Contest
Will be Published in the
October Issue.
More Divisions—More Prizes
More Chances to Win

your hastily penciled ideas as they occur in the course of meeting unusual darkroom problems. You will be surprised how the mere writing down of the idea, even though you may later have the misfortune to misplace the piece of scratch paper, will help you to retain it in your memory to spring into service when needed.

LIGHT REFLECTOR AS VIEWER

WE had been using the light reflector over our darkroom sink as a negative viewer for a long time before we realized what a valuable darkroom accessory our light reflector had become. You have prob-

For viewing negatives

ably seen the type, available for a quarter or so. With a frosted finish, the reflector not only controls light in the normal way, but also acts as a sort of translucent light surface against which translucent objects may be held and viewed. Now we habitually employ this "viewer" for examining negatives after washing and occasionally when selecting negatives in the darkroom for enlarging or printing.

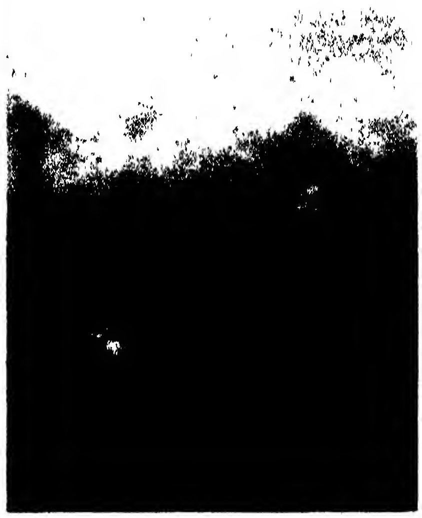
FOR THE SLIPPERY EASEL

HAS it ever happened to you that, after having prepared everything for the final exposure under the enlarger, your easel suddenly slipped and threw off all your neat calculation and arrangement? Why ask! Well, we have found one perfect cure for this

and to date have had uniform success with the scheme. Obtain in the five-and-ten-cent store a supply of rubber stripping having an adhesive on one side; cut off two short lengths, each one a little shorter than the length of the easel. Attach one of the lengths to each of the long sides—underneath, of course!—and your troubles are over.

For the Clouds' Sake

CLOUDS are the making of many a scene that is otherwise of little worth pictorially. There is a glorious beauty to clouds that is probably unmatched by anything in



"Silver Lining"

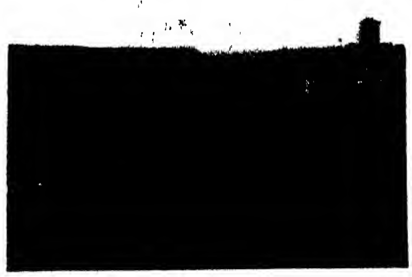
"Lake of the Clouds"

nature and many a photographer has spent his film substance in the wonderfully exhilarating endeavor of attempting to transfer to film and later to record on paper the majestic and often awe-inspiring beauty of those moving white masses. The two examples illustrated here indicate how, by subordinating the foreground, either by keeping it low in the picture space or by leaving it in shadow, the cloud-filled sky gains the emphasis and importance that is its due. A medium yellow filter was used in each case because areas of blue sky were included in the view. A red filter gives interesting dark skies but this would be inadvisable in both instances. In "The Silver Lining" we already

have a dark contrasting mass and in the other little could be gained by a darker sky than we already have. As a matter of fact, it must be remembered that the use of any filter is not required in the very late part of the afternoon when the light becomes yellowish and the sky is no longer the pure blue that it was during the day. The use of a yellow filter, under such circumstances, will usually give you a black sky or at least a very dark one.

Watch Your Foreground

In picturing such a large expanse of area as that included in the accompanying illustrations of a view from Fort Tryon Park, New York City, it is important that the picture be given some balance such as that



Right

Wrong

afforded by the Cloisters building in the first illustration. It provides a sense of perspective, a high point of interest and serves to remove the monotony from an almost completely blank sky. In the second picture the photographer ignored the building, thinking only of the general scene, with the unpleasant result that you see. The building is partly included but seems to be in the picture merely by sufferance because it could not be kept out.

Camera and Gun Exchange Shots

Sounds like a good plot for an adventure-thriller type of magazine, but the picture boys say it's so and have the pictures to back up their story. It seems that recently in Knoxville, Tennessee, a man, charged with traffic violation, was standing outside the courthouse when a news photographer started to "shoot" him with flash bulb exposures. The picture "victim" liked the idea so little that he pulled out his gun and started firing bullets at the photographer. The latter stood his ground, however, and got his pictures anyway. A photograph published in

connection with the story shows where two bullets had struck the wall near where the photographer stood, one of the bullets evidently having come dangerously close.

When Bottle Caps Stick

UNFORTUNATELY certain bottles sold for photographic use are equipped with screw-type metal caps that begin to show rust signs very soon after the first few pourings from the bottle. This rusting is aggravated with continued usage until a time comes when the rust has cut almost completely through the entire inner surface of the cap and difficulty is experienced each time it is necessary to unscrew the cap. The best cure is to purchase or otherwise obtain bottles with plastic screw caps. (There are certain photographic liquid chemicals and solutions that are sold in bottles having this type of cap.)

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope

One-Shot Color Camera

MAKING three color-separation negatives in a single exposure, with each negative sharp and perfectly balanced, the Lerochrom Direct Color Separation Camera ($168 without lens) is offered for general amateur as well as professional use. The camera is of the single reflector type and makes negatives $2\frac{1}{4}$ by $3\frac{1}{4}$ inches, from which it is claimed that the average amateur may make his own full-color prints in enlargements up to 11 by 14 inches.

The camera, the invention of Adrian LeRoy, known for many years for his inventions in the engraving field, is furnished with a densitometer for properly balancing the black-and-white color-separated copies as to contrast and density. The camera employs two special film holders, one of which supplies two of the three color-separation negatives.

Panflex for Contax

PERMITTING the use of a variety of lenses interchangeably, the Panflex is introduced on the market as an accessory for converting the Contax camera into a reflex camera for short-range work. In addition, as previously announced, the Flektoscope is available in three models with long-focus lenses, the Sonnar $f/2.8$, 18-cm, the Tele-Tessar $f/8$, 30-cm, and the Tele-Objective $f/8$, 50-cm. These devices incorporate a mirror coupled with the cable release that operates the camera shutter, so that the mirror is automatically lifted away just before the exposure and returns of itself immediately

after the exposure. The image is viewed under approximately 5x magnification on a fine-grain ground glass, the center of the field being marked by a small engraved cross.

400-MM TELYT LENS

PROVIDING a focal length of 16 inches—16 times greater than the short side of the 1 by 1½ inch Leica negative—the 400-mm Telyt lens ($450.), with lens speed of $f/5$ and focusing by means of a mirror reflex housing, giving ground glass focusing up until the moment of exposure, is now made available for the professional, newsman, and advanced amateur. The weight of the 400-mm Telyt is 7 pounds.

PHOTRIX ELECTRONIC TIMER

ADAPTING a timing method hitherto employed for industrial purposes, the Model B Photrix Electronic Timer ($37.50) is introduced as a device for automatically turning off the enlarging or contact printing light after a predetermined interval. In use, the Timer is plugged into a light socket, the enlarger or contact printer is plugged into the Timer, and the selector switch of the Timer is set at the desired time of exposure. Then a button on the Timer is pressed, which turns on the light of the enlarger or printer, the light being turned off automatically at the end of the indicated exposure interval. Features of the Photrix include: resetting of the Timer required only if the time of exposure is to be changed; being electronic in nature, there is neither motor nor clockwork and no moving parts; a switch is provided for operating printing light by hand and to allow for continuous light for focusing, shading and spot printing.

CAMERA AUTOMATICALLY SETS DIAPHRAGM

COUPLING of a photo-electric cell with the lens diaphragm in the new Super Kodak Six-20 2¼ by 3¼ camera ($225.) makes possible automatic adjustment of the diaphragm to whatever the lighting conditions happen to be for a particular subject. With snapshot shutter speeds from 1/25th to 1 200th second, all one has to do is to select the desired shutter speed and the lens automatically stops down to the exact aperture required for perfect exposure.

A range finder of radically new design is incorporated in the camera; it is mechanically coupled to the focusing mount of the lens and combined with the direct eye-level view finder in a single eyepiece. Double exposures are automatically prevented by a device which precludes re-tripping of the shutter until the film-winding lever is

operated. For special effects the lens diaphragm may be adjusted by hand.

When the camera is held for a vertical picture, the range finder is at the top. Just below it is a multiple collective lens, with the sensitive photo-cell behind it. This multiple lens is so calculated that it covers the exact field of the camera lens, causing the photo-cell to react only to the light conditions in the picture scene. At the moment the shutter is released, the photo-cell actuates the galvanometer in the lens housing, and the diaphragm adjusts to the correct aperture at the chosen shutter speed to produce a technically correct negative.

Tilt-O-Rama, Jr.

The Tilt-O-Rama, Jr. ($4.50) tripod swivel head, made of polished aluminum, has recently been made available. The long goose-neck support allows the camera to be tilted to any position; and a large ball-and-socket joint holds it there firmly.

Enlarging-Paper Box

An ingenious enlarging-paper box, equipped with a spring actuated lid which snaps shut and protects the contents of the box against light as soon as you remove your hand, is now available for those who are tired of fumbling with paper packages and boxes while working in the dark-room. The box ($10.80) holds several sizes of papers and provides a convenient method of storing paper as well as selecting papers of different contrasts, surfaces, and sizes, when doing varied work under the enlarger.

Leica Self-Timer

A self-timing device for the Leica camera incorporates visible-action design and a spring mechanism that trips the shutter after a delay of 12 to 15 seconds. By observing the relative position of a white dot on the face of the slowly rotating winding disc of the self-timer ($5.40), the operator is always aware of the time remaining before the shutter is to be released.

Portable Darkroom

Designed for developing film and making contact prints wherever one happens to be, and in broad daylight, if necessary, the Midget Marvel ($10) has been placed on the market as a portable darkroom completely equipped for the purposes intended. In addition, the device may also be used for loading cut-film holders or developing tanks. The complete outfit contains 14 items, including trays for developing and fixing, negative and paper holder, and so on. In use, the operator inserts his hands into flexible light-proof sleeves snapped over the open ends of the box. A safety glass is placed in the front and another in the top window; an operating hood provides a shelter for the top window through which the worker observes what is happening in the box. For loading and unloading film, darkening boards are provided to fit into the glass holders.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. What is the weakest light by which a photograph may be taken?—D. L.

A. A match flame or candle flame is often employed to show the great sensitivity of certain films, but these, as you will notice, are generally quite close to the subjects. Any illumination, no matter how dim, that makes a subject visible, will enable that subject to be photographed. We are not, of course, concerned here with the matter of the exposure time required and in the case of a portrait an extremely dim light may not be useful at all because of the long exposure that would be required.

Q. Can you give me a formula for sensitizing fabrics or paper? I want something fairly fast, so it can be exposed by projection.—E. W. D.

A. While we cannot vouch for the "speed" in printing that is possible with the following sensitizing formulas, here they are for what they are worth to you. The essential, with all sensitizing processes of this type, is that a snappy, fairly contrasty negative be used for printing. The first solution, which is applied with a wad of cotton in very weak light, a precaution that holds for the other formula as well, is made up as follows:

Potassium ferricyanide .	700 grains
Ferric ammonium citrate (green)	1600 grains
Water, to make	20 ounces

Print out and wash in water.

The other formula:

Water	10 ounces
Common salt	100 grains
Gelatine	20 grains

Dissolve in warm water. Stretch the fabric on a frame and uniformly moisten the fabric by floating the latter, or paper, as the case may be, on the surface of the warm bath for three minutes. When it is dry, sensitize it in a solution of silver nitrate, 40 grains to the ounce. Fix in a bath consisting of one part sodium hyposulphite to six parts water.

Q. What is meant by the term "circle of confusion"?—P. P. A.

A. Light reflected from a photographed subject is registered on the film as a group of circles or disks of light. The smaller the diameter of this circle or disk of confusion (the degree of unsharpness permissible in an image because not perceived by the eye), as it is termed, the sharper the definition in the resulting negative and, as a consequence, in the print or enlargement made from it. A negative intended for enlargement will call for a relatively smaller circle of confusion than one from which only contact prints are to be made. In the case of a 2-inch lens exposing 35-mm negatives, therefore, which often are enlarged to 8 by 10, 11 by 14 and larger, the disk is calculated as small as 1/750th inch, although 1/250th will be found sufficiently small for a lens of about 6 inches focal length, exposing negatives 3¼ by 4¼ inches. For the purpose of devising a depth of field table, discussed in our reply to Rev. R. T. in the July Round Table, a larger disk has the advantage of offering relatively a greater range of sharpness.

Q. I am anxious to know how the coupled range finder is made—the principle on which it works.—E. A. L.

A. The principle of the coupled range finder is similar to that employed for big-gun setting, namely, the use of two prisms, one fixed, the other moveable to cause co incidence of a "split" or "double" image seen in the viewing prism. Drawings and fuller explanations may be found by consulting the Leica Manual and Clerc's "Photography: Theory and Practice."

Q. Would you advise me to use the lens from my camera as an enlarging lens? What is the highest temperature the lens could be subjected to without damage? The lens in question is an Exaktar F:3.5, 5 cm from my Kine Exakta.

Looking through some negatives developed about two years ago by a commercial shop I find one roll is turning purple. What causes this?—I. M.

A. It is a common practice to employ one lens interchangeably on both camera and enlarger. In fact, as you probably know, an enlarger is available specifically designed to take the lens of your Kine Exakta camera. Other camera makes, such as the Leica and Contax, also offer this facility. As to the maximum temperature that the lens will stand, we can say from experience that with a well ventilated housing, even so powerful a light source as the Photoflood bulb may be employed, provided the light is burned

for only very short periods. Such a light, incidentally, might be found desirable only with very dense negatives in order to cut down the time of exposure which might be excessive with a normal light source. As a matter of fact, with a condenser type enlarger such as the one you have, the concentration of the light rays afforded by the condenser lens will provide a strong enough light with a normal light source to take care of practically all negative densities within reasonable exposure limits. However, if a Photoflood is employed, it is advisable to employ a rheostat device in order to cut down the light intensity, and hence the heat generated, during focusing.

The staining of your negatives is probably due to improper processing, the finisher doubtless having used old developer or an old fixing bath or both. If the purple stain is uniform over the entire negative, however, there is nothing to worry about as the stain will merely increase the required printing exposure time.

***Q.* Is there any accepted way of preventing a movie film from drying out and cracking from continued use? Would an application of glycerine help?—B. R.**

A. A number of so-called hardening solutions are available on the market dedicated to the preservation of miniature and motion picture negatives and positives. Any one of these should give complete satisfaction. Storage in a cool place is a good general precaution to observe. As to the glycerine treatment, we learn that this is not to be recommended because films so treated remain permanently damp, thus leaving them subject to the possibility of slow image deterioration through atmospheric action on the silver.

***Q.* I intend to buy a miniature camera. Of two prospects I am undecided as to whether I should buy one with an f/3.5 lens and shutter speeds to 1/500, making album size prints, or a 35-mm camera with an f/2.9 lens and shutter speeds to 1/300. The latter is $20 less but has a cheaper hand strap and winding knobs, and so on. Should I buy the higher priced one because of the greater shutter speed or can I get the same or better results with the cheap one?—R. M. W.**

A. Let us line up the pros and cons. In the first case, you have a camera with a lens of f/3.5 speed, a shutter giving exposures up to 1/500th second and a picture size which we presume to be 2¼ by 2¼ inches. In the other case, the lens is a faster one, but the top shutter speed is slower and the film size is 35 mm or 1 by 1½ inches. Without an inspection of the cameras involved in the choice, it is not possible to make any recommendations, but we gather from your question that what you are concerned with most is the speed of the shutter. On this score, we can say that many amateurs get along very well with a top shutter speed not even as high as 1/300. If you have a special and frequent need for a shutter speed of 1/500, this is something to think about. If not, then the difference in top shutter speeds can be discounted. You cite a cheaper hand strap and winding knob on the lesser priced camera. On the face of it, these are not serious enough to be worth consideration, but you are right in intimating that because of the cheapness of the fittings the conclusion must follow that the general construction of the camera also is cheap. This does not always hold true, but generally speaking the fittings provide some hints as to the worth of a camera. Your decision must rest, however, on the size of negative that you prefer, the quality of the lens, and, if both are approximately equal in value, whether the difference in the speeds of the two lenses means anything to you. Offhand, we should say that the speed of the lens in this particular case is of no great importance. We would place the question of the difference in price at the bottom of the list. In any event, our suggestion is that you have a good heart-to-heart talk with the dealer, state your case frankly and persuade him to do the same.

***Q.* I wish to make my own camera for taking instant pictures (stamp size) on "direct positive paper," pictures to be taken indoors. Will you please tell me what lens to use and if I could purchase it second hand? What special basic knowledge would be needed?—J. M.**

A. The lens you will need will have to be of 2-inch focal length or a little less if you want to include a view of about 50 degrees, which is the "normal" photographic angle of view. If you want to get less on your picture (that is, obtain a larger image), your lens would have to have a longer focal length, perhaps 3 inches or more. Lenses may be purchased second hand from any of the large dealers; you can find some of the addresses in the advertisements in this department. The basic knowledge required is that needed for the construction of any camera and this may be learned by consulting some elementary books on photography that include such descriptions.

***Q.* In loading with 120 or B-11 roll film for a heavy day of picture-taking, I find that carrying a half dozen rolls adds up to quite a bulk when carried in the coat pocket. I have, therefore, adopted the habit of taking the rolls out of the boxes, thus cutting down the bulk considerably. Is this an unwise habit?—L. H.**

A. The method you cite should be perfectly safe provided the rolls are allowed to remain in their foil wrappers and are kept in a bag that can be closed up to protect the rolls from dirt. The exposed rolls can be returned to the same bag; there can be no confusion as to which rolls have been exposed and which are still unexposed because the latter will remain in their foil wrappers until ready to be loaded into the camera.

***Q.* In using the brilliant finder of a camera I have just purchased, I find that the subject in my prints appears on the extreme left of the prints, although in taking the picture the subject is perfectly centered. Is this natural with a view finder of this type?—P. F. P.**

A. A view finder is designed, as the name indicates, to reveal the view or picture subject being photographed. There is, therefore, no excuse for the discrepancy in image framing that you mention and our best advice is that you return the camera to the dealer from whom you purchased it. He will have the camera adjusted so that the view encompassed by the lens is practically that which you see in the view finder.

Books

SELECTED BY THE EDITORS

SOILLESS GROWTH OF PLANTS

By Carleton Ellis and Miller W. Swaney

AT last! So great has been the up-surge of interest in this new science of chemical gardening and so many have been the requests to us for complete information regarding this method, that we can say "at last" with almost a sigh of relief. Popularly written, this volume brings to the layman complete information regarding the problems and difficulties of tank farming and gives the solution in each case, together with formulas for the chemicals to be used and instructions for preparing tanks and other containers. While this volume may be limited in certain respects, it is to be recommended to all those who are interested in experimenting with the method, either indoors as a hobby or out-of-doors as a commercial venture. (155 pages, 6¼ by 9¼, illustrated.)—$2.90 postpaid.—*F. D. M.*

TRIUMPH OVER PAIN

By René Fülöp-Miller

AROUND the discovery of anesthesia 94 years ago and the end of horrible pain in surgical operations, the author of several notable books (such as "Rasputin, The Holy Devil") has woven a spell of charm backed by accurate science and exhaustive historical research. Two Americans claimed credit for this discovery. To one the credit was given, while the other became a raving maniac. Even today this bitter battle rages. How theologians, and scientists too, fought the use of anesthesia and how it supremely won—these things and numerous others are told in this fascinating volume.—$3.70 postpaid.

PORTRAIT PHOTOGRAPHY

By H. Williams

STEP by step the author takes the reader through the principles of lighting and portraiture, making the way plain for those approaching for the first time this phase of photography. For those who have attempted portraiture in the past, with more or less satisfactory results, the suggestions given will prove helpful in attaining more perfect workmanship. Fundamental principles of lighting and composition, clearly explained and illustrated, serve as a basis for the development of a satisfactory technic. A chapter is included on retouching, giving details that often are left to the imagination of the reader. (68 pages, 6½ by 9½ inches, numerous photographs and drawings.)—$4.45 postpaid.—*A. P. P.*

ASTRONOMY

By Robert H. Baker, Professor of Astronomy, University of Illinois

OF the six or more extant texts of astronomy some are long, some medium, some shorter. Some are kept up to date while some have lost their edge. The Russell, Dugan and Stewart Astronomy is the most detailed, the Moulton text the most readable, the Fath text probably the most lucid and compact, the Duncan text the most attractively produced. This new and third edition of Baker's text, now published, may be characterized as the most detailed text that is closely up to date. It is dated May, 1938, while the closest runner-up is dated 1935. Its star maps—four one-page simple maps of the seasonal constellations, plus two circumpolar maps—are greatly improved. Some new photographic illustrations have been substituted for old. Some chapters have been rearranged. The account of the galactic system has been largely rewritten to follow the developments in the active field. New readers who are unfamiliar with textbooks of astronomy often harbor the belief that they are mainly mathematical. On the contrary, the science, for all except the case-hardened professional, is adequately covered in elementary college texts having less than 1 percent of mathematics, and even this may be skipped. Thus this fascinating science, with its frequent revelations of undreamed-of vastness, is easily absorbable from books like this by the average intelligent reader. (527 pages, 5 by 9 inches, many illustrations.)—$3.95 postpaid.—*A. G. I.*

PSYCHOLOGY OF SEX

By Havelock Ellis

A NEW edition of a book published in 1933 and written by the greatest and foremost contributor to the subject of scientific sexology, who offers in it much excellent advice. It covers the usual scope and is written in a very lucid, easily read style. (377 pages, 5½ by 8½ inches.)—$3.20 postpaid.—*A. G. I.*

BREATHE FREELY!

By James Kendall, Professor of Chemistry, University of Edinburgh

THE oft-denied tale of super-war gases is here denied again in words that cannot easily be contradicted even by the sensation mongers, exhorters, and arm-flailers. In this volume the author develops his theme logically from a study of the gases used in the past War and of little-known facts concerning present work in chemistry, to the end that civilian populations may be reassured. He does not believe the ghastly predictions of wholesale slaughter behind the lines in the next war with poisonous gases or by air bombing, and the reasons he offers bear out his argument. We welcome this eminent chemist's contribution to a steadily growing literature which tends to prevent the sleepless nights that some people have had in recent years after reading in the sensational press of the horrors that are to come. (179 pages, 5 by 7½.)—$1.60 postpaid.—*F. D. M.*

WETTING AND DETERGENCY

Foreword by W. Clayton

FIRST in the English language dealing with wetting and detergency, this work is important for the chemist, physicist, and engineer, whether industrial or academic. It presents in a concise form the most modern theoretical considerations of the subject and their bearing on industrial problems. And these problems do abound in such industries as those concerned with textiles, hides, skins, leather, paints, varnishes, insecticides, fungicides, flotation, solders, metal coatings, and many others. The data in this book are the most complete on these subjects seen by this reviewer. Eminent scientists have prepared this work, which is up-to-date in every respect.—$6.20 postpaid.—*F. D. M.*

EAT AND KEEP FIT

By Jacob Buckstein, M. D.

A POPULAR treatise on foods, vitamins and cognate subjects, with instructions for dieting. (128 pages, 5 by 8 inches.)—$1.10 postpaid.—*A. G. I.*

COLLEGE PHYSICS

By Henry A. Perkins, Professor of Physics, Trinity College

A TEXTBOOK covering both the classical and newer physics, without the too-common over-emphasis on the latter at the expense of the former. The treatment is detailed but conventional, for this is not an attempt to humanize physics. The language of mathematics (high school) is freely used. An excellent reference book and source of study or review for serious readers. (820 pages, 6 by 9 inches; many illustrations.)—$4.00 postpaid.—*A. G. I.*

JEWELRY, GEM CUTTING AND METALCRAFT

By William T. Baxter

THE author is a high-school teacher of the subjects treated and his handbook is chiefly practical. While it is about 75 percent explicit, it is not wholly so. Even so, it would be an invaluable aid to workers in any of the hobbies treated in it—many of whom, in fact, prefer not to be instructed too minutely but to explore or adventure a little and find out the lesser details for themselves. The numerous illustrations tell much of a practical nature; the names and addresses of dealer sources of materials are given in full. (224 pages, 5½ by 8 inches, 128 figures.)—$2.65 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

FURTHER to emphasize the merits of a type of refractor previously described in these columns (Oct., '37, p. 232) we present a follow-up on the same instrument, reproducing Figure 1 again from the earlier publication. Capt. Maurice A. Ainslie, R.N., the owner, who stands next to the telescope in the picture and who is well known in British amateur circles because of his work in practical astronomy ("Astronomy in Navigation," a chapter in "The Splendour of the Heavens," by Instructor Capt. M. A. Ainslie, Royal Navy), writes from Grenville, Talbot Drive, Wallisdown, Bournemouth, England, concerning this "reflex" type of telescope:

"It has occurred to me that some further remarks concerning the instrument—which has now been in regular use for two years—might be of some interest to your readers. As shown in your photo, the triangle which forms the base of the mounting stands up clear of the ground; this was soon found to cause some inconvenience, as well as to make the eyepiece rather inaccessible in some positions; so the triangle has been sunk 6" in the ground with great advantage. At the greatest northern declination (about 43° north) which permits of the telescope passing the meridian without reversal, the lower end of the tube just swings clear of the ground, while the eyepiece is always readily accessible. In respect of convenience of working, the instrument equals, if it does not surpass, a reflector with rotating tube; and the optical parts, once adjusted, are so stable that finding objects by the circles is an easy matter. This is just as well, since it has not, as yet, been found easy to mount the finder so as to be easily accessible in all positions; the arrangement shown in the photo is probably about the best, but is not very satisfactory; however, since the finder is hardly ever used, this does not matter very much. The 'swiveling' arrangement for the eyetube, giving a side-to-side range of some 225°, has been found very advantageous—especially for work on variable stars—as the orientation of the field of view is always under control.

"Of course, with two reflections between the object glass and the eyepiece, some loss of light is bound to occur; assuming 87 percent for the reflectivity of the aluminized 6" flat, and the same figure for the prism, the effective aperture of the object glass is about 8.4" x 0.87, or about 7.3"; this gives ample light for such powers as can usefully be employed on Jupiter; while I find that my not very sensitive eye can just see steadily a star of magnitude 13.7 on a good night, so that there is sufficient light for observation of pretty faint variables.

"The circles, which are divided only to half degrees and read by simple pointers, bring any desired object into the field of a low power eyepiece giving x 60 and a field of 43'; and the remarkable stability of the whole stand goes a long way toward making 'setting' easy and certain; repeated tests on the Pole Star have failed to show any

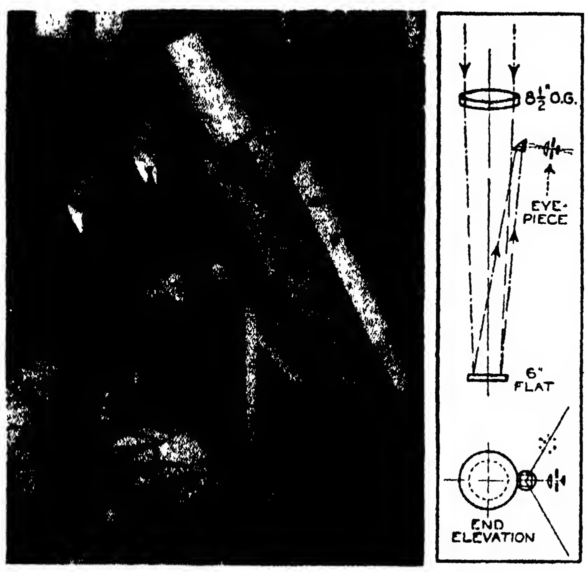


Figure 1: The reflex euphonium refractor

appreciable movement in the polar axis.

"I venture to think that anyone possessing an object glass of similar, or even greater, aperture, might do worse than consider the possibilities of this form of mounting, especially for prolonged observation of such an object as a planet."

The photograph reveals less distinctly than the drawing the position of the eyepiece, the latter being foreshortened in the photograph. Commenting on this, Horace E. Dall, of Luton, Beds., England, who made the optics (the mounting was made by Perry, also shown in the photograph) states:

"The whole point of that extra reflection is accessibility of eyepiece and orientation of image. The Captain is keen on planetary work, in estimating position angles of Jovian spots, and so on. He prefers to set the belts horizontal, which is easily done by swinging the short, projecting eyepiece tube 'round."

So far as is known, no American amateur has yet made a reflex—or "euphonium."

BECAUSE glass, such as that from which mirror blanks for reflecting telescopes are made, is cooled rapidly on the outside after it is poured, stresses due to unequal contraction are set up in it. Annealing in a lehr is supposed to ease off these internal stresses but does not always do so. Later, when the telescoptician removes glass from parts of the disk, these stresses (for some unknown reason called "strain" by the optical industry) are able to warp the disk out of shape, and then there is grating and gnashing of teeth, for the disk is probably a candidate for the discard.

Last April, H. E. Dall, of England, told in these columns how he had designed and built an inexpensive tester for strain in glass, making use of the new polarizing material, Polaroid. This tester, he stated, consisted of (1) a lamp in a blackened box having an opening covered with Polaroid; (2) a ground glass screen; (3) Polaroid goggles worn by the viewer. He added that this simple equipment "showed up strains so brilliantly that there was no need even to test in a darkened room, subdued light sufficing to permit the indications to reveal themselves."

F. M. Garland, 1006 Davis Ave., Pittsburgh, Pa., read this note, obtained a few more details from England and built a Dall tester. He now writes: "Scanlon and I tested all the glass within reach at the Valley View Observatory with it and the set-up really works." Therefore we have obtained from Garland some of the details.

Starting at the lower, left-hand corner of the photograph (Figure 2) the following elements of the set-up are seen: (1) A wooden box, hinged beneath for adjustment in altitude and containing an ordinary 25-watt lamp. Fastened over the hole in its front, this hole being made as large as the polarizing material will permit, is one half of a pair of Polaroid goggles of the kind now obtainable at many filling stations, with their normally horizontal dimension vertical. (2) An easel with a pane of common window glass frosted on one side, to provide a fairly uniformly illuminated area of polarized light large enough to permit the examination of a moderate sized disk against it. (3) The glass under test, held in the hands. If the glass is not strained, the expansion due to the heat of the hands will give it a strain, hence it should be insulated with a cloth or felt; but if the desire is to study the effect of heat in causing temporary strains, no insulator should be used. (4) A pair of Polaroid goggles worn in the normal manner, which will cause the horizontal dimen-

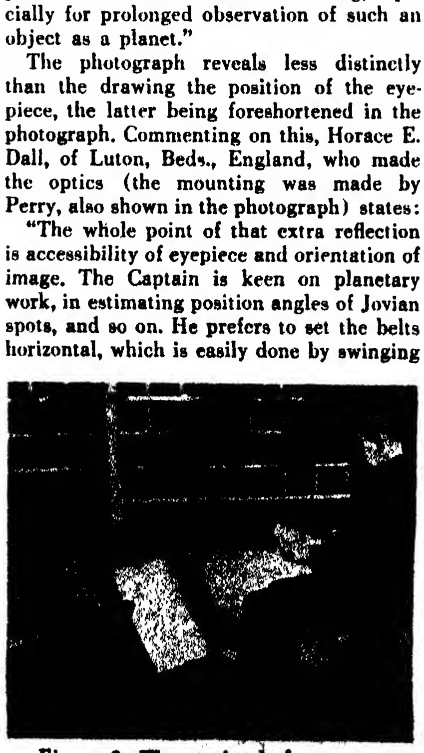


Figure 2: The strained glass tester

sion of the lenses to cross that of the Polaroid in the lamp box and thus be at right angles to one another. (5) The eyes of the tester—in Figure 2 these are the property of F. M. Garland. The photograph was taken at our request.

"When the glass is badly strained," Garland points out, "dark and light streaks are seen strongly contrasted against the fairly dark screen. Faint shadings are inconsequential; but if there are strong bands it is best not to work such a disk. If no bands can be seen it is interesting to make some, simply by warming the mirror with the hands."

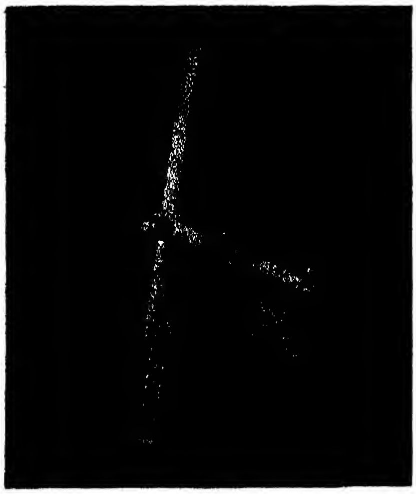


Figure 3: Garland's spotter

The above paragraphs may supersede the description of apparatus in ATM, page 461. When that description was prepared, only a few years ago, no such low-cost, large-area polarizing material as Polaroid was anywhere available.

PORTABILITY is a quality many seek in telescopes which they wish to carry about in a car. Figure 3 shows a little 1⅞" refractor with ½" eyepiece, giving about 30 diameters magnification, owned by the F. M. Garland mentioned above. The mounting is a bar with a bend equalling the latitude, and the fork is attached to it by means of a quarter-inch removable pin, as shown. By giving the bar a curve instead of an angle, such a telescope would be adjustable for any latitude and be suitable for the wandering type of telescope user.

THAT the Republica de Argentina is very much on the telescoptical map is evidenced by a letter from a member of the "Amigos de la Astronomia," in Buenos Aires, Carlos Luis M. Segers, Calle José Bonifacio 1488—the address of the library of the Association. Segers, who writes better English than some of us Yanks, says many amateurs have made and are now making telescopes in the Argentine Republic and that ATM and ATMA are thoroughly known in those latitudes. They have published in Spanish an excellent booklet on telescope making and they regularly publish the *Revista Astronomica*. This is an amateur journal but is quite professional in appearance, judging by the samples sent to your scribe.

IN a chapter in ATMA, Hindle of England tells how to make a diagonal for a Newtonian and states that, while the use of a totally reflecting prism is permissible, we must use an optical plane of elliptical con-

tour if we desire the very best results. Commenting on this in the present department some time ago, Wates of Canada showed the very small losses of light caused by other types of diagonal.

Replying to Wates, Hindle now adds the further fact that "the use of an elliptical flat insures that the black spot [the spot at the center of the diffraction pattern, which is the shadow of the diagonal.—*Ed.*] is perfectly circular, and one can easily judge the perfection of the instrument by the out-of-focus images of a star. Not only the permanent characteristics of the telescope but the varying characteristics due to temperature changes can be immediately determined." He quotes from a letter by W. H. Steavenson, prominent English amateur astronomer:

"Other things being equal, I think there is no doubt that the ellipse is the shape of choice, since it combines circularity of projected outline with a minimum of obstruction. The objection to any other shape (necessarily presenting a larger area by projection) is not, to my mind, concerned chiefly with reduction of light-grasp; because, as Wates has shown, the loss in ordinary cases is negligible from a practical point of view. The drawback consists rather in the production of increased or unsymmetrical diffraction effects or both. *Any* central obstruction tends to throw a certain amount of the light from a star into the diffraction system surrounding it, which is objectionable from certain points of view, though inevitable in all practical forms of the reflector. The most we can do is to keep the obstruction down to a minimum, as is done by adopting the beveled ellipse. Any increase in size of obstructed area increases the amount of diffraction, as may be seen by taking the extreme case of a flat so large as to leave only a narrow annulus of main mirror exposed. In this case you get a slightly *reduced* central image, but an enormously enhanced ring system, which would blot out any close faint comparisons and also destroy contrast in planetary detail.

"In any case," Steavenson continues, "I should always, even at the expense of slight extra loss of light, fit a circular disk as a mask over the flat mount, since any other shape, square or elliptical in projected outline, will produce unsymmetrical effects. The square gives four rays, and the ellipse two, though these may be so oriented as to coincide with those produced by the supports.

"But actually, as I said at first, none of these effects is *very* important in its bearing on practical performance, and, to quote Bell, they 'affect the observer's feelings more than his images.' The matter only becomes important with small *f* ratios, when the flat is necessarily already on the large side in comparison with the main mirror. Thus for *f*/4 the change from the elliptical type with circular projection to the circular flat of same minimum projection, or to a type with projection filled out round by a mask, might be really serious, though fortunately the work done by such mirrors is generally photographic, where definition under high powers does not enter into the question. For the ordinary amateur's visual work, at say *f*/6 to *f*/8, I don't think much harm would result from a projection of *any* reasonable size or shape."

Thus the beginner needn't worry *very* much about the shape of his diagonal. Figure 4, drawn by Wates, provides an organized picture of the ins and outs of it. Wates' comment on the statements by Hindle and others is as follows: "I should imagine it would be just as easy to get used to an elliptical extra-focal spot as to a circular one; that is, as a standard of performance. My whole object was to point out that, while the beveled ellipse is undoubtedly the ideal shape, there is no serious objection to an unbeveled, circular disk which does not apply equally to a prism. The advantage of the circular disk is the ease with which flats of this shape can be made. All this is for the 12-incher, not for the 6-incher who, of course, uses a prism, or the lordly 20-

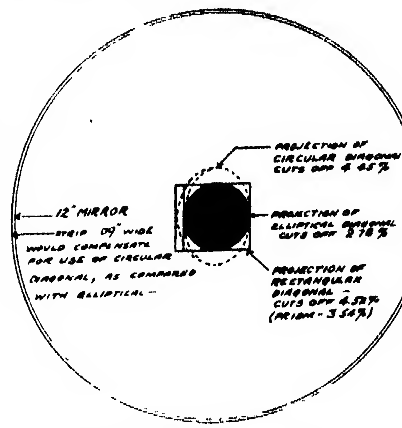


Figure 4: Wates' diagonalology

incher who doesn't give a whoop for trouble or expense."

A good many letters received from amateurs are passed round by your scribe among other amateurs, much like family letters passed to relatives, and when Everest saw the collection reproduced above he added the following on a cognate subject:

"I agree that the elliptical diagonal at 45° is the best. Another thing is that, for uniform diffraction effects, the projected circle must be concentric with the mirror's axis, which will make it appear off-axis when viewed from the focal point at the side of the tube. Most tyros don't understand this, and try to correct for the apparent displacement, but a simple geometrical diagram will show why it can't be done. Also, theoretically, this means adding slightly to the size of the diagonal as usually calculated for complete coverage of the field lens of the eyepiece, but it's not important."

Everest then proceeds with the following train of logic:

"1. The whole plea for the elliptical diagonal is to project a *circular* shadow on the mirror, so that its figure can be interpreted from the extra-focal image of a star, also to produce uniform diffraction around the image at focus. The light gain over the rectangular diagonal is insignificant.

"2. To produce concentric rings in the extra-focal image, as shown at *A*, Figure 5, or uniform diffraction effects around the in-focus image, this circular shadow must be concentric with the axis and rim of the mirror. If this condition does not exist, the extra-focal image will be as at *B*, with rings not concentric, while the in-focus image will be cockeyed to the critical observer.

"3. For freedom from astigmatism, the axis of the cone of light reflected from the mirror must coincide with the axis of the mirror.

"4. For the same reason, the axis of the cone of light reflected from the diagonal

must coincide with the axis of the ocular.

"5. For 3 and 4 to be possible the intersection of the axes of mirror and ocular must lie in the plane of the diagonal.

"6. If you agree with 1, 2, 3, 4 and 5, you must also agree to the construction shown in Figure 5.

"7. If you agree to 1, 2, 3, 4, 5, and 6, you must also agree that, when viewed from the focal point, you will see something like *C*.

"8. If you have followed thus far, you will see that the *area* of the diagonal actually used in reflection will be as shown in D.

"9. If you cut down the diagonal to the area actually used in reflection, the projected circle will not be concentric with the mirror's axis.

"10. If you push the diagonal toward the mirror (dotted line), as most tyros attempt to do, the cone of light between diagonal and ocular will be off the ocular axis, resulting in astigmatism.

"And there you are.

"The extra size of diagonal needed to accommodate the field lens of the lowest power ocular used has not been considered in the diagram, as this would complicate the explanation.

"The amateur who is interested only in seeing the splendors of the heavens through his telescope needn't worry much about all this theory—as it is not important from a practical standpoint. This is directed at the armchair telescope makers with the hope that it will cause them no end of worry."

TOO convenient is a common belief that a poor flat will do for a diagonal "because it is used close to the focus." Due to frequent repetition without examination, this error has acquired sanctity. But F. J.

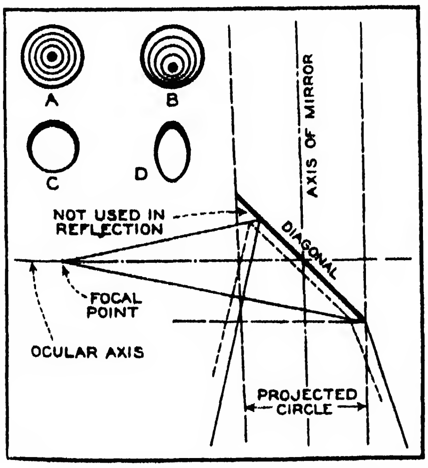


Figure 5: Everest's diagonalology

Hargreaves has analyzed the question, in the *Journal B.A.A.* If a large surface having uniform departure from flatness were used, so that the reflected beam filled the whole surface, the error would equal that of this surface. If less of the same surface were used, the error would be reduced (the linear error being reduced in the ratio of the squares of the diameters taken), and perhaps that part of the uniformly curved surface might be near enough to flat to be harmless—not, however, directly because of its nearness to focus. Distance, as such, has no effect. In other words, as Hargreaves puts it, "A small part of a large bad mirror may be good, but it does not follow that a small bad mirror is a good one."

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

Reduce the Waste Line in Heating Your Home is a brief, illustrated description of a gas-fired home heating and air-conditioning unit of novel design. *C. A. Dunham Company, 450 East Ohio Street, Chicago, Illinois.—Gratis.*

Canada Your Friendly Neighbor Invites You presents an attractive series of photographs and colored plates, and an intriguing story, all designed to lure the tourist to the wide variety of recreational facilities offered by our northern neighbor. This booklet will be of value to anyone who is considering visiting Canada for either business or pleasure. *Canadian Travel Bureau, Ottawa, Canada.—Gratis.*

Technical Characteristics of Alcohol-Gasoline Blends is a 16-page pamphlet that presents a carefully considered and authoritative discussion of the various technical characteristics of such blends. Data have been obtained under carefully controlled test conditions; the conclusions drawn may therefore be considered highly authoritative. *Committee on Motor Fuels, American Petroleum Institute, 50 West 50 Street, New York City.—Gratis.*

Bargain Book of Cameras and Supplies is a 32-page catalogue which lists and describes hundreds of cameras, both still and movie, together with a wide variety of lenses, tripods, and other photographic accessories and supplies. *Central Camera Company, 230 South Wabash Avenue, Chicago, Illinois.—Gratis.*

The Fact Manual of Standard Electrical Porcelain presents in a large folded sheet pertinent data regarding the use of porcelain in domestic and industrial wiring. Installation suggestions are given, together with tabulations and drawings that will interest the electrician, the home owner, and those in shop management who are concerned with the subject. *Standard Electrical Porcelain Mfrs., 201 North Wells Street, Chicago, Illinois.—Gratis.*

Statistical Abstract of the United States, 1937 assembles in one compact volume of 839 pages data on practically every phase of the social, economic, and industrial life of the nation. Included are 857 tables presenting statistics from the earliest available date up to the present day. Subjects covered include area, population, vital statistics, national wealth and income, wages and employment, manufactures, construction, and so on. *Superintendent of Documents, Government Printing Office, Washington, D. C.—$1.50 (check or money order).*

The ABC of Navigation, by George A. Boyce, is a popularized presentation of navigation for marine and air travel. Illustrated with photographs and diagrams, it gives the essentials of the use of charts, the sextant, the compass, and so on. A chapter is included on dead reckoning. Low-priced but accurate navigating instruments are listed and described. They are satisfactory for use by the amateur navigator who has neglected to provide himself with equipment because of the high costs that formerly prevailed. *Boyce-Meier Equipment Company, Bronxville, New York.—25 cents.*

Worthington-Carbondale Refrigeration Compressors describes a vertical duplex double-acting unit with enclosed crankcase suitable for the requirements of large-tonnage installations. *Worthington Pump and Machinery Corporation, Harrison, New Jersey.—Gratis.*

Railroads and Railroad Wages 1938 condenses into a 16-page booklet pertinent facts regarding the present railroad situation and the wage scales of railroad workers. *Bureau of Information, Eastern Railways, Room 5710, Grand Central Terminal, New York City.—Gratis.*

Fire-Protective Construction on the Farm shows the fire hazards that exist in various types of building construction and how they may be overcome. It is estimated that the annual loss by fire on farms is approximately $100,000,000 worth of property and 3500 lives. Farmers' Bulletin No. 1590. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Scenarios is a 44-page pocket-size booklet designed to give instruction in the art of writing scripts for commercial motion pictures. The booklet will be of interest to anyone who has ever considered motion pictures as an advertising medium. *Alexander Film Company, Colorado Springs, Colorado.—Gratis.*

Look Your Best in Glasses drives home the fact that glasses need not detract from a person's appearance. When this fact is realized, many people who need glasses and have avoided them will gain the benefits which come from the proper care of their eyes. *Bausch & Lomb Optical Company, Rochester, New York.—Gratis.*

The New Atlas Shaper is a small but interesting catalogue which presents close-up views of the most frequent shaping operations, together with complete construction details and technical specifications. *Atlas Press Company, 1830 North Pitcher Street, Kalamazoo, Michigan.—Gratis.*

Soil Erosion by Wind is an 86-page book which tells the factual story of the severe dust storms of the central United States, pointing out in both photographs and text the steps that can be taken to prevent further erosion. *Kansas State Board of Agriculture, Topeka, Kansas.—Gratis.*

Rayons at Retail is a 16-page pamphlet prepared by the producers of rayon yarns to give the facts about the textiles as simply as possible. The information will be of assistance to both buyers and sellers of rayon at retail. *Rayon Yarn Producers Group, 51 Madison Avenue, New York City.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Illegal Brokerage

THE intricate provisions of the Robinson-Patman Act are slowly being clarified by the federal courts. It will be recalled that the Robinson-Patman Act is an amendment to the Clayton Anti-Trust Law and is intended to eliminate price discrimination in transactions affecting interstate commerce.

The latest section of the Act to be judicially construed is the very important Section 2-C which prohibits the payment of commissions or brokerage fees by sellers of merchandise to purchasers or to the agents or representatives of purchasers.

The Circuit Court of Appeals for the Second Circuit recently confirmed an order of the Federal Trade Commission prohibiting certain practices which were construed to be violations of Section 2-C of the Robinson-Patman Act. In the case in question a corporation engaged in the business of selling market information to its subscribers for a fee of $25 to $50 a month also represented its subscribers in making certain purchases of merchandise. The corporation entered into written contracts with its subscribers whereby the subscribers employed the corporation to make the purchases. When purchases were made by the corporation it received a brokerage fee or commission which was remitted to the subscriber for whom the purchase was made. In most instances the commissions remitted to the subscribers in this manner did not exceed the subscription fee for the information service. However, in approximately 14 percent of the cases the commissions did exceed the subscription fees.

The Commission instituted proceedings against the corporation and several of the subscribers and sellers doing business with the corporation, charging that the practices as outlined above constituted a payment of brokerage fees or commissions to the agent or representative of the purchaser, in violation of the Robinson-Patman Act. After a hearing and taking of testimony, the Commission ordered the corporation and the purchasers and subscribers to cease and desist from these practices and a petition was filed with the Circuit Court of Appeals to review and set aside the order. The Circuit Court of Appeals affirmed the order of the Commission, holding that the disputed section of the Robinson-Patman Act did not violate the Fifth Amendment to the Constitution and that it was a valid regulation of interstate commerce.

The difficulties encountered in construing and interpreting an intricate statute such as the Robinson-Patman Act is indicated by the fact that one of the three judges of the Circuit Court of Appeals dissented from the decision of the majority and held that the practice of remitting commissions and brokerage fees to the subscribers, not in excess of the subscription fee paid for the information service, did not constitute a violation of the Act. The dissenting judge agreed, however, that the payments made in excess of the subscription fee did constitute a violation of the Act.

This case is of great importance to companies engaged in interstate commerce or in competition with firms engaged in interstate commerce, and it is believed that because of the importance of the issues involved an attempt will be made to have the decision reviewed by the Supreme Court.

Where There's Smoke

A PERSON who copies only a small portion of a copyrighted book may be guilty of copyright infringement even though he gives credit to the copyright owner, according to a recent decision of a federal court.

A manufacturer of cigarettes published an advertising pamphlet in which it paraphrased three sentences from a book on the human voice written by a prominent physician. The paraphrased portion of the pamphlet read as follows:

"Statistics have it that 80 percent of physicians are smokers * * * It appears unanimous that smoking is not nearly so injurious as over-eating * * * From my experience with ear, nose and throat cases, I firmly believe that tobacco, when properly used, has no ill effect upon the auditory passages."

The copyright proprietor brought suit for copyright infringement, alleging that the publication of the pamphlet had cast reflections upon the professional ethics of the physician and had retarded the sale of the book. The cigarette manufacturer contended among other things that only an insignificant part of the copyrighted book, that is, three sentences, had been copied, and that in any event the pamphlet contained suitable acknowledgment of the source from which the material had been taken. Because of this it was argued by the cigarette manufacturer that the pamphlet could not be construed as infringing upon the copyright. The court rejected both of the defendant's contentions, pointing out that even though the three sentences in question only formed a small part of the copyrighted book, they formed an important and material part thereof. In this connection the court stated:

"In order to constitute an infringement of the copyright of a book it is not necessary that the whole or even a large portion of the book shall have been copied. It is sufficient if a material and substantial part shall have been copied, even though it be but a small part of the whole."

With regard to the acknowledgment the court stated:

"While the acknowledgment indicates that it did not intend unfair competition it does not relieve the defendant from legal liability for the infringement."

Unloading

WE have pointed out before that where an inventor discloses his invention in confidence prior to the granting of a patent he can recover damages from the confidant if the confidence thus reposed has been abused. This principle has been reaffirmed in a recent rather important case.

In the case in question a railroad corporation requested bids for the construction of car-dumping apparatus used for loading coal on cargo vessels from railroad cars. One of the bidders, the plaintiff in the case under consideration, submitted in connection with his bid a drawing and description of car-dumping apparatus which bore the following notice: "This drawing is the property of R. W. Kaltenbach Corporation. It shall not be copied or duplicated in any manner, and shall not be submitted to outside parties for examination without our consent. It shall be used for reference to work under contract or proposals submitted by this corporation only."

Thereafter the railroad company awarded the contract for the construction of the car-dumping apparatus to another bidder. It was contended by the plaintiff that the drawings submitted to the railroad company showed certain important new features; that the drawings were submitted in confidence as shown by the notice; and that the railroad company violated the confidence and arranged for the manufacture of apparatus embodying the plaintiffs' new features. At the time that the apparatus was constructed for the railroad company the plaintiff did not have any patents covering it. However, thereafter he obtained two patents covering the apparatus and brought suit against the railroad company charging patent infringement and breach of confidential relationship. The Court found that the apparatus constructed for the railroad company did embody the new features developed by the plaintiff and which were submitted to the railroad company in confidence and held that the railroad company had infringed plaintiffs' patents and also had breached the confidential relationship existing between the bodies prior to the granting of the patents. The plaintiff accordingly was awarded damages on the theory of patent infringement subsequent to the granting of patents and on the theory of breach of confidence prior to the granting of patents.

In support of its decision the Court quoted an opinion in a prior case as follows:

"Under such circumstances, we think that defendant should account to plaintiff for the profits realized from its sale of the infringing device prior to the grant of plaintiff's patent, not under the patent statutes, but under the long-recognized principle of equity that no man ought to be allowed to enrich himself unjustly at the expense of another."

SCIENTIFIC AMERICAN ADVERTISERS
September · 1938

Advertising Manager
CHARLES H STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill
BLANCHARD-NICHOLS-COLEMAN
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Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York
ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 159, No. 3, 35 cents a copy $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • OCTOBER • 1938

TESTS of communication systems for open-cockpit airplanes are conducted in the "noise chamber" of Siemens and Halske, illustrated on this month's cover. A small wind tunnel forces a blast of air against the experimenter's face, simulating aircraft operating conditions. Motor and other noises are produced by means of phonograph records which are amplified and reproduced by the large loudspeaker directly behind the experimenter. A "contact" type microphone is placed against the experimenter's throat to insure a maximum transmission of his voice. *Photograph: German Railroads Information Office.*

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, October, 1938. Vol. No. 159, No. 4, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of October, 1888)

STREET CARS - "Electric traction cars, in the place of horse cars, began making trips in the public service on the Fourth Avenue line, New York City, on September 17, the Julien storage battery system being employed. The battery for a car consists of 144 cells."

ARMS—"The idea of a nation with the wealth and mechanical skill of the United States having to go abroad for its guns for warfare is ridiculous. Sporting arms, equal in workmanship to any manufactured in the world, are made in this country, and there is no reason why the heavier ordnance should not also be made here."

DEFENSE—"The neo-modern fort, conformable to the type devised by Commander Mougin . . . the construction of which upon a certain position selected near the [French] frontier has been ordered by a ministerial decision of July 23, 1887, has a singularly original character. Let one imagine to himself a bulging of the earth, recalling on a large scale one of those hillocks produced by the subterranean work of the mole. We have not here, however, a mass of earth, but rather a block of beton. This artificial rock, measuring fifty yards in length by from thirty to forty in width, rises from a dozen yards beneath the natural ground. Its maximum projection above the earth does not exceed three or four yards. . . . At the center of this rock rise, flush with the surface, three armor-clad turrets . . . each armed with guns of large caliber; at the circumference, four small disappearing turrets, each armed with rapid-firing guns; and at three other properly selected points, armor-clad observatories. . . . The underground machinery department includes a powerful steam engine, with cistern and duplicate boiler, a battery of ventilators for renewing the air, accumulators with pumps, and hydraulic motors for raising, lowering, and revolving the turrets and elevating the ammunition, etc., and, finally, dynamos and electric accumulators for internal lighting and projecting light externally."

MEXICAN—"Rapid progress has been made this summer toward the completion of the Mexican National Railroad Company's 'International' line, and President Raoul informs us that it is expected to open it for traffic before November 1, and possibly by October 15. This will make a second independent all-rail route from the Rio Grande to the city of Mexico."

PRE-MIXED—"A new idea has been developed in Germany, in the shape of the manufacture of mortar, to be sold at retail to small builders and private individuals. The business requires very little capital, and the mortar, which is mixed by machinery, and of excellent quality, finds a ready sale, something like two million barrels having been disposed of last year in Berlin alone."

STARS—"In the whole celestial sphere, there are about six thousand stars visible to an ordinarily good eye. Of these, however, we can never see more than a fraction at any one time, because a half of the sphere is always below the horizon. . . . In all, 314,926 stars, from the first to the ninth and one-half magnitudes, are contained in the northern sky, or about 600,000 in both hemispheres. All of these can be seen with a three-inch object glass."

MAN-MADE DIAMONDS—"The Hon. C. A. Parsons describes . . . a number of experiments which he has recently made on carbon at high temperatures and under great pressures, and in contact with other substances. The primary object of the experiments was to obtain a dense form of carbon for use in arc and incandescent lamps. . . . Looking at the experiments from this point of view, it may be stated that the experiments were not entirely successful, though a very dense form of carbon was in one case obtained, but nevertheless some results are of very great interest, as, though the author expressed himself very cautiously, it would appear that he has succeeded in producing diamond dust artificially. . . . There was obtained on the surface of the carbon . . . a powder of a gray color, harder than emery, and capable of scratching the diamond. This powder is, therefore, very probably the diamond itself."

TREE MINING—"An industry the like of which does not exist anywhere else in the world furnishes scores of people in Cape May County, New Jersey, with remunerative employment, and has made comfortable fortunes for many citizens. It is the novel business of mining cedar trees—digging from far beneath the surface immense logs of sound and aromatic cedar."

CENSUS—"The census of 1890, preparations for which are already being made, promises to show in the United States a population of more than 70,000,000. The population in 1880, according to the census of that year, was 50,155,783 persons, of whom 43,475,840 were native and 6,679,943 foreign born."

BALLOONS—"While experiments are being made in England to solve the problem of the manufacture of balloon hydrogen by electrolysis, *Iron* informs us that Messrs. Majert and Richter have devised and successfully experimented with, at Berlin, an apparatus that does away with the inconveniences of former processes. The hydrogen is obtained by heating a mixture of slaked lime and powdered zinc, the carriage of which on a campaign is rendered easy by inclosing it in tin cartridges."

COAL—"The principal coal mines in Japan are situated on the island of Takashima, outside the harbor of Nagasaki. They form one of the principal centers of coal supply in the East, and have now been worked by a lessee of the government's with all the more recent and improved appliances for about sixteen years past. According to a recent official report, 2,500 miners are engaged, the total population of the island being 10,000."

AND NOW FOR THE FUTURE

Cotton picking machines—the practical and economic aspects of these devices—by F. D. McHugh.

The Italian Navy at a glance—two pages of drawings with explanatory text.

Potash and other valuable salts are being obtained on a commercial scale from the Dead Sea—by Harold J. Shepstone.

Industry profits greatly by the use of new hard alloys in tools and wearing surfaces.

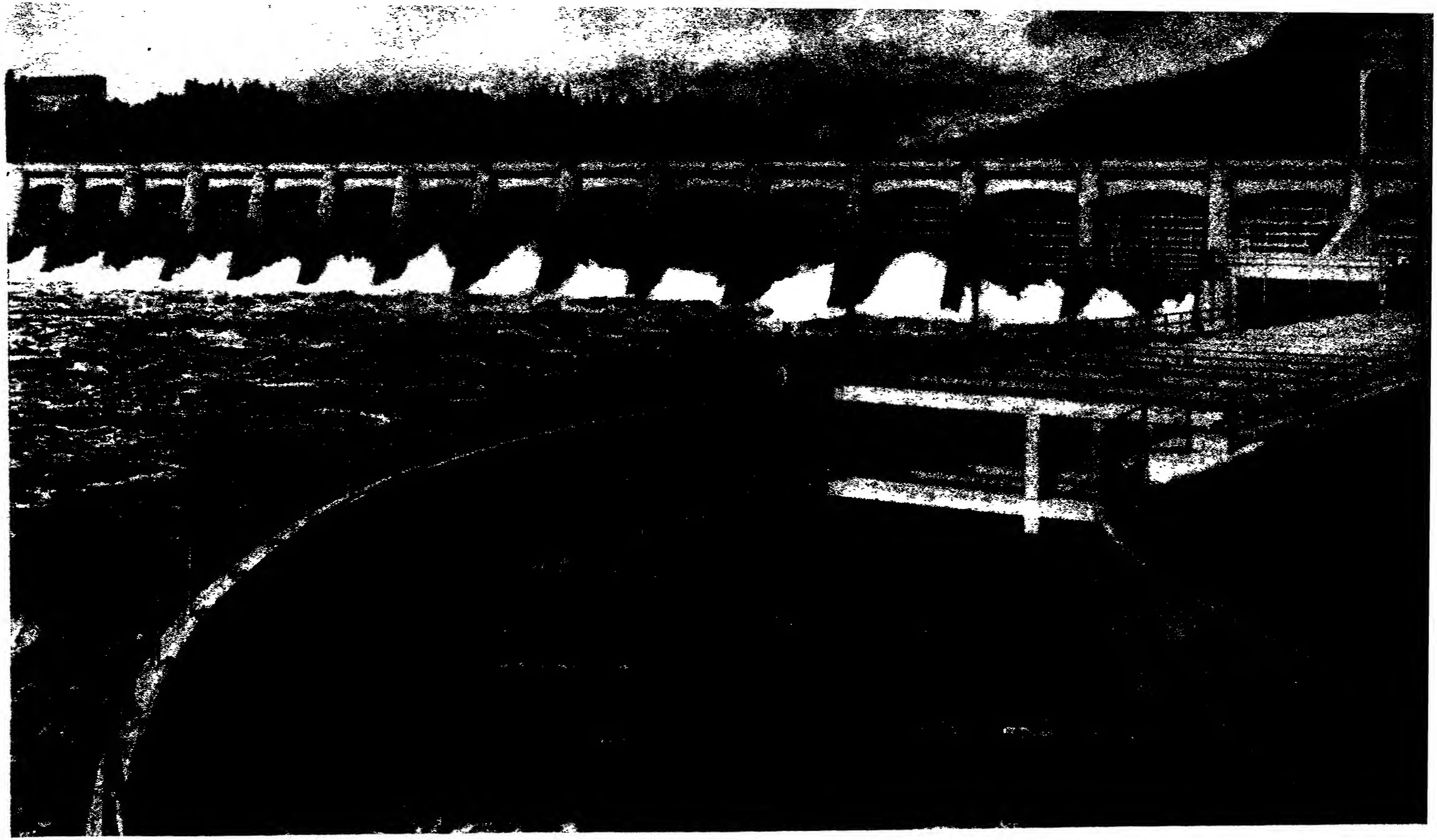
"And I Can Make It Talk"

You're right about that, Sonny. At eight or eighty it's easy for any one to use the telephone. And year after year the service gets better and better.

This country leads the world in telephone service because it leads in telephone research. Thousands of scientists, engineers and assistants are constantly at work in the Bell Telephone Laboratories to make the service faster, clearer and more economical. No part of the Bell System is more important to you as a telephone user.

BELL TELEPHONE SYSTEM

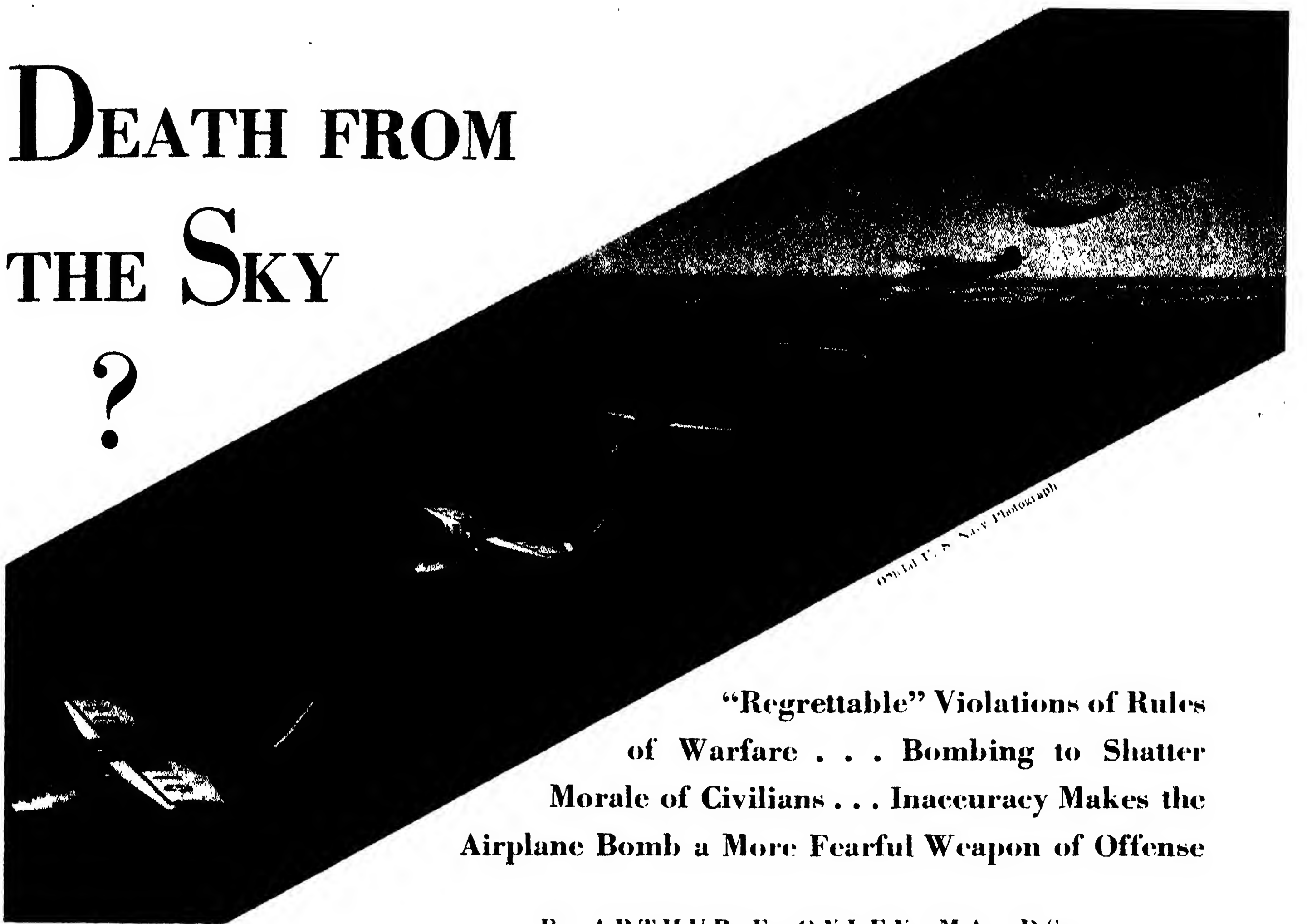
Your good telephone service is made possible by the constant research of Bell Telephone Laboratories



MAN-MADE CATARACTS FOR FISH HURDLERS

BROAD as a four-lane highway: one of the fishways at Bonneville Dam, the lower end of which is in the distance near the main, or spillway dam (see map on page 182). Salmon migrating upstream hurdle these steps, from pool to pool, finally reaching the higher level whence they swim on upstream to their spawning areas. Reports by official enumerators indicate that these fishways present no obstacle to this regular migration.

DEATH FROM THE SKY ?



"Regrettable" Violations of Rules of Warfare . . . Bombing to Shatter Morale of Civilians . . . Inaccuracy Makes the Airplane Bomb a More Fearful Weapon of Offense

By ARTHUR E. OXLEY, M.A., D.Sc.
Major, Royal Air Force

A BOMB released from an airplane has but a remote chance of hitting the prescribed objective. Many factors are involved in determining the flight of a bomb, several of which are either not known or are difficult to ascertain. In many cases, particularly during a daylight attack, the activities of enemy pursuit planes and anti-aircraft gunnery prevent a bomber from using even the scanty data available, and frequently compel him to "lay his eggs" without taking a sight at all. In night bombing, these interfering factors are partly eliminated but a "black-out" adds enormously to the bomber's difficulties. Not until he looks down, perhaps half a minute later, and sees the cloud of black smoke by day or the pin-point flash by night, does he realize "where that one went."

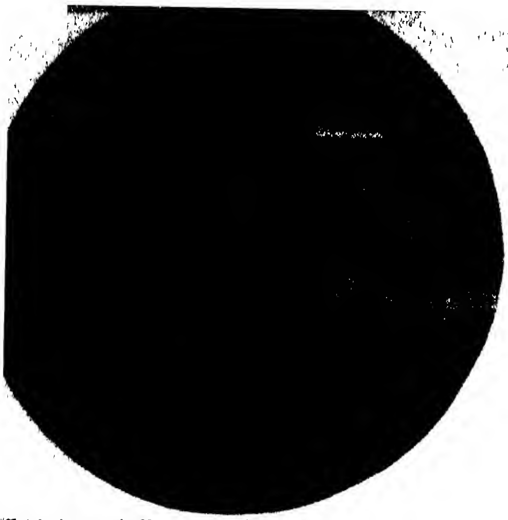
Knowledge of these facts makes aerial bombing a fearful weapon in the grasp of relentless modern commands. It allows them to commit crimes against hitherto established international rules of warfare; to kill or maim non-combatants; to destroy non-military structures. Under cover of the plea that his objective was a legitimate one, that his efforts were directed honorably, that the results—alas! so "regrettably" wide of his intentions—were accidental or unavoidable, a ruthless command may plan to shatter the morale of an enemy's civil existence in the hope of insuring indirectly an economical military conquest.

Within the past 25 years, airplanes have revolutionized the military and naval conduct of war. Their outstanding contribution to warfare admittedly lies in the sphere of reconnaissance—acquisition and transmission of intelligence. Airplanes are the eyes of a fleet or army, displacing the less agile sea-scout or destroyer and the relatively slow-motion cavalry. They constitute the gunners' range-finder for unseen craft and battery emplacements. They are the tipsters of the invisible knock-out.

TODAY the airplane has largely dissipated what the strategist aptly called the "fog of war" of yesterday. That it may be the means of creating a fog of its own, infinitely more disastrous than any fog yet conceived, is also probable. This we shall discuss later.

Such a valuable adjunct to land and sea forces must naturally create a rival. This appeared in the form of the fighter plane—a perfectly legitimate device—the object of which is to protect its own reconnaissance units and destroy those of the enemy. And so the airplane was transformed from a non-aggressive adjunct of the fighting forces to a weapon of offense. The next step in the evolution of the airplane as an offensive weapon was the attempt to make it simulate long-range artillery, resulting in the birth of the bomber. The projectile to be launched is comparable with that of a howitzer. The range of the aerial bomb corresponding to that of the latter is provided by the flight of the airplane but, instead of the projectile traveling throughout its flight in a calculable trajectory, like the howitzer shell, the aerial bomb is merely released with a velocity exactly equal to that of the plane at the time of release. In fact, we may regard the bomb as being fired from a platform at the height of the plane, the muzzle velocity of the bomb being the actual velocity of the plane relative to the ground.

The height of the plane above the objective is readily obtained from the altimeter reading, correcting, if necessary, for the elevation of the objective above sea level as indicated on a contour map. The determination of the velocity of the plane relative to the ground is a more difficult problem. It depends on the air-speed of the plane—that is, the speed at which the plane flies horizontally in still air—as well as on the velocity and direc-



Official photograph, U. S. Army Air Corps
Attack plane dropping gas bombs on "enemy" anti-aircraft battery during recent maneuvers

tion of the wind at the height of the plane. These last factors are characteristic of the spot *near* the objective *at the time* of release, and are usually not known with any degree of accuracy. Some idea of their value over the objective may be obtained by preliminary flights, or from balloon observations, at a safe distance from enemy interference —trusting, from judgment of weather conditions, that similar or only slightly modified conditions may exist over the objective.

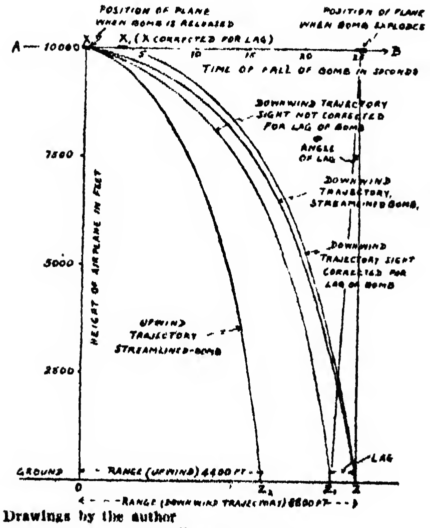
NOW, if the bomber knows all details of air speed and ground speed, wind direction and velocity, it is possible for him to set his bomb-sight either for an upwind or downwind approach to the objective. The range—the horizontal distance between the objective and the position of the plane at the instant of release—will be very different (Figure 1) according as to whether the plane is flown up- or downwind. The trajectory of the bomb is approximately that of the parabolas shown. The diagram in Figure 1 represents the following concrete case:

Air-speed of plane=150 miles an hour.
Height of plane above objective=10,000 feet.
Wind velocity at this height=30 miles an hour.
Ground-speed of plane (downwind)= 180 miles an hour; 264 feet per second.
Ground-speed of plane (upwind)=120 miles an hour; 176 feet per second.
Theoretical range of bomb (downwind), OZ=6600 feet.
Theoretical range of bomb (upwind), OZ_2=4400 feet.

The parabolic trajectory XZ would be traced by an ideal *streamlined* bomb released with its axis parallel to the line of flight and so stabilized that, in its forward and downward flight, it does not wobble. In actual practice, none of these conditions is realized. Most bombs are only approximately streamlined, except for their tail stabilizing fins. which, like the feathers of a dart, are necessary to prevent undue wobbling as the speed of descent increases and the curvature of the trajectory changes. No aerial bomb is favored with the stabilizing gyroscopic spin imparted to an artillery shell, as its copper band threads its way through a rifled bore. Therefore the bomb wobbles—it can be seen to do so as it leaves the plane—and in so doing it, in effect, becomes less streamlined. Owing to the resultant head-resistance, the horizontal speed of the bomb during each second of its fall is gradually reduced below that of the speed at the time of release. The plane keeps up this speed because of its engine power; the bomb, having no such propelling power to counteract the head-resistance, lags behind a direct vertical drawn through the plane.

From a height of 10,000 feet, a well streamlined bomb takes a little over 25 seconds to reach the ground. Each type of bomb has its own lag, and all that can be done to compensate for the intricate variants due to bomb shape, height and speed of plane, and so on, is to modify the height and time-scales of the sighting mechanism so as to allow for an average lag representative of an average-most-commonly-used type. This lag, ZZ_1 in Figure 1, is measured by dropping either dummy or unfused actual bombs.

A CAMERA obscura which, curiously enough, originated in the 13th Century through the genius of Roger Bacon. and which was conceived by him for developing the arts, may be used for measuring bomb lag. A sketch of this device is shown in Figure 2. It consists of a darkened chamber in the roof of which is inserted a convex lens L. Below the lens is a table on which is pinned a sheet of white paper, the distance from the center of the lens to the paper being equal to the focal length of the lens. Any object, say a cloud or an airplane, may be considered as at infinity and will form a sharp image on the paper. If a plane flies over the camera obscura in the direction AB, an image of it will move



Drawings by the author

Figure 1

across the paper in the opposite direction, *ab*. The pilot is instructed to fly upwind and downwind, these directions being obtained through use of the drift indicator. A metronome is set to beat one-second intervals and an observer places a pencil dot, at the beat of each second, on the image of the nose of the machine, tracing the image (Figure 3) in both its up- and downwind tracks. For the upwind track, the ground speed is low and the dots are close together; for the downwind track, the ground speed is high and the dots are far apart.

As the plane moves from A to B, the image moves from *a* to *b*, the similar triangles ABL and *ab*L (Figure 2) giving the scale of flight reduction by *ab*/AB=*a*L/AL. From this, knowing the

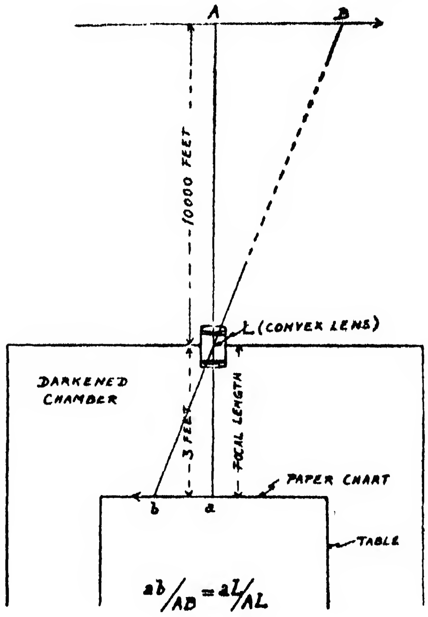


Figure 2

number of seconds required to trace the track *ab*, we get the ground speed, upwind and downwind, respectively. Suppose the bomber is aiming at a target, the bearing of which relative to the camera obscura O is marked to scale on the camera table. The bomber signals by radio the instant he releases the dummy bomb and the observer marks the instant of this signal at X (Figure 3) on the track of the plane's image. A tangent to the track at X gives the projection of the bomb's line of flight on the ground and the point of impact of a theoretically streamlined bomb is found by measuring a distance XZ equal to distance between second dots at X multiplied by time of descent of bomb in seconds. The actual point of impact of the dummy bomb is measured on the ground outside and its position transferred to the camera obscura chart. The difference between the range calculated and that measured gives the lag which is required. The average of about 20 tests gives a sufficiently accurate estimate of the lag, and allowance is made for this amount in the graduation of the sights

that are used on the bombing plane.

With these corrected sights, the bomber would now release his bombs (Figure 1) at X_1 instead of at X; that is, he would release late to compensate for shooting short due to the head-resistance of the bomb.

Even when every effort has been made to evaluate these variables, there still are unknown factors with which the bomber has to contend. From heights of 15,000 to 20,000 feet, now chosen by bombers, there is little to fear from anti-aircraft guns; but as height increases, errors increase, and prevailing air currents in lower strata of the atmosphere may even oppose those above. Enemy pursuit planes have still to be faced. They are faster and can fly still higher, harassing the bombers at critical moments and vitiating their aim.

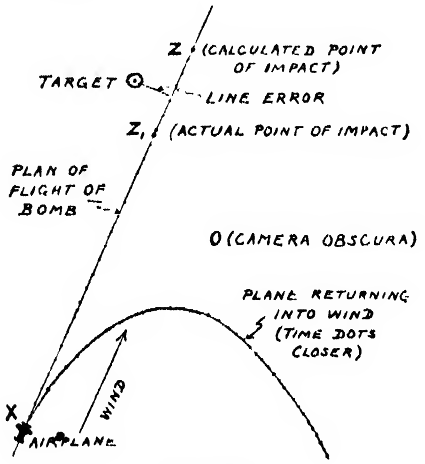


Figure 3

Errors of the order of 20 percent in range, over or short, also right or left, of an objective are common; this percentage is usually greatly exceeded under exigencies of war where the bomber is threatened with attack. On a range of 5000 feet, the minimum error may be set at 1000 feet north, south, east, and west of a target. Quite large buildings are therefore too small, as individual objectives, to be hit by direct skilful sighting. More reasonable objectives are dockyards, large camps, factories, and aerodromes.

During the World War and in a few recent attacks, bombs have been launched while diving to low altitudes. As in the case of low-altitude machine gunning, this practice eliminates almost all the unknown variables referred to above, the line of flight of the bomb being approximately the line of flight of the machine over its short trajectory as shown in Figure 4. In such cases the bombs must be equipped with delay fuses to allow the bomber time to zoom clear before explosion takes place. The risks entailed by low-altitude bombing, except in the cases of attacks on unarmed populations or savage tribes, are too great to make this a popular mode of aerial attack. In most of the calamitous raids of the last two or three years, greater and greater altitudes have indicated a growing respect for the defender. And poorer and poorer become the efforts of the attacker until we may say that they have ceased to be discriminative!

Another way of reducing the uncertain factors affecting the trajectory of a bomb is that based on the vertical dive. A plane diving vertically will reach a terminal velocity of 500 to 600 miles an hour. At this speed the upward head-resistance counterbalances the weight of the plane and the plane falls without further gain of speed. This is approximately the speed at which the bomb of Figure 1 strikes the ground. Such a speed would not add appreciably to the accuracy of bombing, but it would have very serious effects on a pilot's endurance in executing the maneuver out of the dive, to say nothing of the probable collapse of his machine! Such vertical speeds can be avoided by taking advantage of the reversible pitch propeller. With this, the vertical speed downward can be reduced to approximately the speed of horizontal flight. In dive bombing of this type, the bomber executes his dive vertically above the target—a definite drawback to the method. In bombing from horizontal flight, the bomber need not approach his target much closer than a mile, and, immediately he has released his bombs, he may bank away and return to his aerodrome.

THE vertical dive method only partly solves the difficulties of the bomber. A plane so falling is still drifting with an uncertain wind velocity. For example, in the concrete case cited above, a wind drift of 30 miles an hour is assumed. If this is not allowed for, a bomb released when diving at 10,000 feet will drift about 1100 feet from the vertical; that is, from the target. Here is very large error when the dangerous maneuvers involved are taken into consideration! In addition, the acknowledged military advantages of formation flying would be sacrificed, at least during and subsequent to the dive.

The use of bombing airplanes as long-range heavy-artillery units has completely revolutionized warfare, particularly in the early stages of attack. The

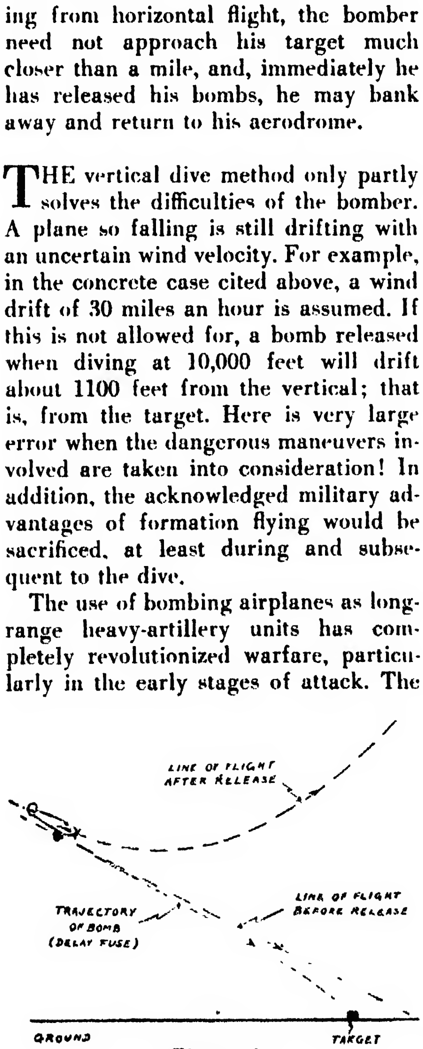
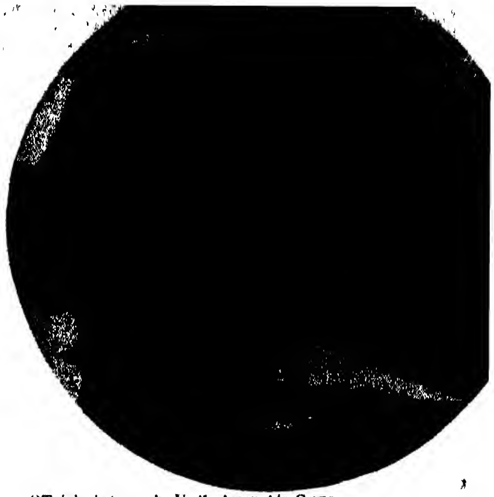


Figure 4



Official photograph, U S Army Air Corps

Loading a dummy "bomb" preparatory to con ducting camera obscura tests as describe

inception of the reconnaissance plane automatically dispersed the then extant "fog of war." Reprisals against this efficient reconnaissance system have resulted in plane armament, finally evolving a purely offensive plane—the long-range bomber, whose swift, unascertainable deployment has created a higher, wider, deeper, and more impenetrable "fog of war" than mankind has ever hitherto conceived. This new monster is the more terrifying because the very fog itself is the destroyer. Some of the powers that embrace this unbridled scourge on humanity will not stop at high explosive and incendiary bombs. The policy to which they are addicted demands the destruction of all and sundry—annihilation! The aim of aggressors is to add to the new "fog of war" every destructive agency that can be adapted to military use. Experiments in earmarked laboratories and over selected flying areas are reported to be making rapid advances toward this monstrous achievement.

The bewildered man-in-the-street may well ponder: "Will the airplane, and particularly the modern long-range bomber, succeed as a unit of offense?" It appears that certain present-day high commands are willing to gamble on the effect of thrusting the hellishness of war directly into the faces of civilian populations. Thus they hope that these helpless people may be forced to plead for even unconditional surrender of rights so that the way will be paved for a cheap military victory.

On the other hand, this modern and inhuman way of conquest may have precisely the opposite effect. It may stiffen backs under the goad of pitiless slaughter of compatriots and engender a potential vengeance which one day will result in an eclipse of the ephemeral military conquest.

Although the outcome of the airplane offensive by means of aerial bombings remains an unknown, indeterminate quantity, the world may be sure that the unwholesome atrocities which are happening today are but curtain-raisers on insane dramas to come.

The X-Particle's New Brother

Still Another Atomic Entity Threatens to Add Itself to the Physicist's "Who's Who in Atomic Society" . . . Is It Real or Is It a False Alarm?

By DOUGLAS W. F. MAYER

UNDER the title "And Now the X-Particle," in the July number of Scientific American, Jean Harrington reported the discovery of two new sub-atomic particles—the positive and negative heavy electrons. Owing to the fact that these particles—which were found to occur in cosmic-ray showers—had a mass *intermediate* between that of the proton group of particles and that of the electron group, the discovery of these new entities, by Anderson and Neddermeyer, of the California Institute of Technology, aroused tremendous interest in physical circles. But science never stops to gain its breath, and hot on the heels of these new offspring has come yet another—the "neutretto."

Just as the neutron is the neutral particle of the proton group, so is the "neutretto" the neutral particle of the heavy electron group. Its presence has, it is true, not yet been confirmed experimentally, and the particle at present is merely a postulation by W. Heitler, produced as a result of some brilliant mathematical work. So well, however, do the predicted properties of this "little stranger" fit in with our existing knowledge, that most physicists are in favor of accepting it, and look upon its concrete isolation as merely a matter of time.

Heitler, of Bristol University, England, is already well-known for his theoretical work on various aspects of nuclear physics, and was led to his neutretto hypothesis by a study of a particularly penetrating type of cosmic-ray radiation, which is capable of producing charged secondary particles and showers. As was explained in a footnote to Jean Harrington's article, these showers are bursts of electrons, which are sometimes exploded simultaneously from the same nucleus by the violent impact of a cosmic-ray projectile, but which are more commonly cumulative, and build up in steps from a single impact. Thus, by interacting with the nucleus, the incoming particles produce a photon, which in turn produces positive and negative electron pairs, which radiate new photons, and so on until the energy is absorbed.

Owing to the high rate of absorption of the electrons and positrons, these particles cannot travel far. But in 1936, Barnóthy and Forró found that, after cosmic rays had traversed absorbing material equivalent to 800 meters of water, practically the whole ionization produced in their detection chambers was due, not to radiation, but to shower particles. From this they concluded that whatever was producing the showers must be due to some non-ionizing particle—that is, a particle with no charge—and suggested that these particles might be neutrinos.

Similar research was performed by Heinrich Maass, who investigated the formation of secondary ionizing particles by "neutral rays" passing through iron, and their subsequent absorption. It was found that the initial neutral radiation had an absorption coefficient of about 9×10^{-4} per centimeter of iron. This was practically the same as that of charged heavy electrons, which also occur in these showers. The secondary charged particles had absorption coefficients of about ten times greater, which suggested that they were heavy electrons moving relatively slowly, and hence more likely to be absorbed.

HEITLER wanted to know what the particles in this neutral radiation were, and realized that, since they were neutral, there were only three things they could be. They were either neutrons, neutrinos, or some new neutral particles hitherto unknown. They could not be neutrons, which have a smaller penetrating power, nor was there any process known in theoretical nuclear physics by which the mysterious neutrinos could produce heavy electrons in the large numbers in which they occur in these showers. Heitler was forced to the conclusion that they were some new type of particle and, remembering that they were absorbed in a similar manner to ordinary heavy electrons, postulated that they were the *neutral counterpart of the heavy electron*, and proposed for them the name neutretto.

Additional support for his suggestion was found in a slightly different sphere. In recent theories of nuclear forces, the heavy electron has been made responsible for the exchange forces between a proton and a neutron. This may sound rather vague at first, but becomes intelligible when we remember that these particles may be looked upon—to put it rather crudely—as lumps of "solidified energy." It was found that the forces between two protons were similar to those between a proton and a neutron, and a similar explanation was sought. Such an explanation, however, required the existence of a particle with the same mass and with similar properties as the heavy electron, but with no charge. Heitler's neutretto supplies the missing link admirably.

Heitler believes that, apart from processes where charge is involved, such as in ionization or the production of light, the neutretto will produce the same kind of showers as those produced by heavy electrons. He denotes this symbolically—as follows—and suggests that a neutretto (Y^0) can be transformed into a heavy electron (Y^+ or Y^-) by colliding with a proton (P) or a neutron (N). The double arrows indicate that the process will work in either direction.

$$Y^0 + N \rightleftharpoons P + Y^- \text{ or } Y^0 + P \rightleftharpoons N + Y^+$$

He has also shown mathematically that for energies of about 10^8 electron-volts, neutrettos and heavy electrons would have cross-sections permitting them to traverse about 7 centimeters of iron, 5 centimeters of lead, or 50 centimeters of water before such a collision took place. With higher energies, more complex showers, resulting in the formation of heavy electrons in large quantities, would take place. These theories are in excellent accordance with experiment.

It thus seems reasonably certain that these new neutrettos definitely exist, and that the heavy electron family has now its full trio of negative, positive, and neutral particles. The electron family, consisting of electron and positron, is still one member short, as is the proton group, consisting of proton and neutron, though several experimenters, at one time or another, have claimed to have detected a negative proton, which would complete the latter group. As for the neutrino, this is still as problematical as ever—the joy of the mathematicians, who ascribe to it all sorts of mysterious properties, and the bane of those who like to have an intelligent comprehension of the things they read about. The only certain facts about it seem to be that it has no charge, and that its mass is very minute.

OUR POINT OF VIEW

Progress Report

"WHEN will television turn the long-talked-about corner?" is the composite sum and substance of numerous letters that have reached this writer's desk. There is no pat answer; no date can be set. And when the corner is reached it will be found to be a long, sweeping curve rather than a sharp right-hand turn. Although research technicians are working constantly to iron out the wrinkles of this new art-science, they realize more and more that the ultimate goal is still far in the future. Standards of transmission are being set, so that there will be no Tower of Babel when television is presented to the general public. Problems of screen detail and illumination, of synchronization and transmission, are being spread out on laboratory tables, knelt upon, and attacked hammer and tongs. Field tests are showing the way to overcome difficulties that will arise when television is finally released. Program possibilities and problems are being studied with a view toward ultimate production of the finest possible eye entertainment and commercial sponsorship.

Television is here—in the laboratory. This writer has made similar statements in these columns in the past, and repeats himself now with even greater emphasis. A recent demonstration of RCA television revealed an image some seven by ten inches in size that had all the clarity, detail, and screen illumination that could be desired. The old criterion of comparison with home movies has been met—and surpassed. The reproduced image was a far cry from the blurred, indistinct and jumpy images in tests of only a few years ago. The only fly in the ointment, from the standpoint of the man in the street, was that this was a laboratory demonstration, staged under laboratory conditions, and with a staff of laboratory technicians present to see that the elusive image behaved itself for company.

But it showed what can be done in the matters that more directly concern the ultimate consumer. It was in the nature of a dramatic progress report that showed definitely what can be expected in the future.

Co-oxial cables for television networks, short-wave transmission experiments (even into the region of a billion cycles), high-efficiency reproduction units—all are contributing their parts to the ultimate television system. Engineers hesitate to say how soon you will have perfected television receivers in your homes, and when there will be available adequate television programs, but sound progress is being made. And such sound progress is far preferable to a mushroom growth based on scanty technical knowledge; such growth would be bound to end with a dull and sickening thud.—*A. P. P.*

Surely They Stumble . . .

ASSUMING that man's evolution from his ape ancestor has occupied about 1,000,000 years—some now say longer—we may say that as recently as the point 99 percent along his road he had only his own muscles as engines of energy for doing his useful tasks. At about this point—roughly 10,000 years ago—he learned to control and use for his purposes the energy engines of the horse and the ass and the ox, a multiplication of muscle of about ten.

Going on with the same scale, which of course is oversimplified but comes within orders of size or duration, man had lived 99.99 percent of his whole career before he discovered and widely applied the steam engine. Now the horse itself was multiplied by something else.

Finally, a decade or so ago, at about the point in his total history indicated by the fine decimal fraction 99.999, the machine age had brought each individual in this nation control of the energy of something like 30 slaves—some say more.

At about this point in human history something entirely new came into being. Strong-willed individuals—dictators, men plentifully provided with the three lusts of possession, prestige, and power—for the first time came potentially into control of nations, hemispheres, and the whole world. This was made possible through the perversion of the energies made available as never before by science—the energy stored in gasoline and high explosives controlled on an unlimited geographical and instantaneous time basis by those other gifts of science, the telephone and radio. There is danger already that, through this unique combination in history, all our past gains may be reduced to ashes.

Now there is a movement afoot among scientists to multiply man's available might once more by converting the energy of coal direct to power, also by utilizing the power of the sun direct (the dream of atomic energy, far more vast than either of these, having happily vanished). May it not perhaps be wise for man, before making this second great adventure in "playing with fire," to hold off for a while and learn how to digest and control what he has, including his own nature? Otherwise we may discover, before we have added another ten years to our million, that we are suddenly pretty well back toward where we started.—*A. G. I.*

Home Again?

AFTER more than a decade of relegation to limbo, the question of bringing back to this country the original plane of the Wright brothers, first to conquer the air at Kitty Hawk in 1903, has been brought to the fore again. Controversy waged bitter some years ago when the Smithsonian Institution installed as a permanent exhibit Professor Langley's machine which did not fly until after that of the Wrights (and after it was equipped with a different engine). When Smithsonian exhibit-labels and literature indicated that this was the first successful airplane, the Wright machine was shipped abroad and has since been exhibited in the Kensington Science Museum in London.

Chief Justice Charles Evans Hughes will soon be petitioned, in his capacity as Chancellor of the Board of Regents of the Smithsonian Institution, to correct the "historical inaccuracies" of the records so that the Wright plane may be brought home. The organizers of this new effort are well-known aviators, members of the newly incorporated Association of Men with Wings. Their petition is to be circulated throughout the nation to obtain numerous signatures.

It is no exaggeration to say that the situation as it stands today is distorted history. The new Association is correct when it says that the contribution of the Wrights is accepted by scientists and technicians of the world—with few exceptions. And its desire to bring out the true facts is meet and proper, for the Smithsonian is the official museum of the nation accredited as the historian of our progress. Therefore the aim of the Association to correct the "inaccuracies" which "prevail in Smithsonian papers in the libraries of the world" so that the facts "may be described unquestioned to posterity," is indeed a laudable one. Once these official papers are corrected, an important step will have been taken toward the success of efforts to bring the Wright plane home.

The least said about the old arguments on this question, the better. Recriminations will be useless and in bad taste. Blaming any individual or group for the earlier decision will not help now. The Association of Men with Wings will do well to remember that only a calm appraisal and a judicial attitude will settle the question to the satisfaction of all. —*F. D. M.*

MAN-MADE DIAMONDS

Making Diamonds Synthetically... Difficulties... 90 Tons per Square Inch, 7000 Degrees Fahrenheit... The Experiments Give Every Appearance of Success

IN the past nine years, more than 50 diamonds have been made synthetically at McPherson College, McPherson, Kansas, ranging in size from the smallest, one millimeter (about 1/25 inch) in diameter, to the largest, which is two millimeters by one and one-half millimeters by one millimeter, and weighs 1/30 carat. This is still the largest synthetic diamond on record. Six smaller diamonds were made in the same experiment, in which gum arabic carbon was added to molten iron and the mass cooled in an ice-brine solution.

It is the opinion of Dr. J. Willard Hershey, head of the chemistry department at McPherson Collge, that only technical difficulties stand in the way of the commercial production of diamonds. Dr. Hershey is supervising student work in synthesizing diamonds, with the hope that some day science will discover a method of making larger synthetic diamonds. A great deal of work still remains to be done before diamonds can be produced on a commercial basis.

The diamond is one of the most fascinating forms of carbon, itself one of the most interesting of the 92 elements because of the many forms in which it is found pure and the infinite number of compounds of which it is a component part.

Many attempts have been made to synthesize diamonds. Among the first was that of J. B. Hannay, of Glasgow, who began his experiments in 1879 and, after many trials, is said to have produced some diamonds.

THE most successful of the early attempts was that of Henri Moissan, a Frenchman who, after patient and careful experiments, succeeded in 1896 in obtaining minute particles which he believed to be diamonds. His largest specimens were 3/100 inch in diameter. Moissan's method was to heat carbon and iron in an electric furnace, at a temperature which seldom exceeded 2000 degrees, Centigrade. The carbon was dissolved in the liquid iron and, by cooling this molten mass rapidly, he attempted to change the black amorphous carbon into a diamond crystal by the pressure exerted by the rapidly cooling iron.

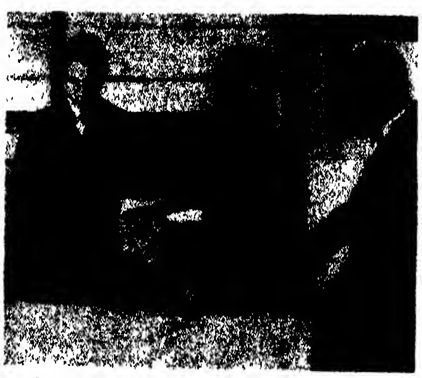
In 1923 an article appeared in a McPherson, Kansas, newspaper to the effect that diamonds had never been manufactured and, in the opinion of its writer, a noted scientist, never would be. Dr. Hershey read the article with interest because, secretly, for years, he had

THE accompanying article is composed of data obtained from McPherson College, through the American Chemical Society. In publishing it, Scientific American does not necessarily concur in all the claims made in it. In the long past, so many of the apparently final successes in this quest have later proved to be disappointments that an attitude of defensive caution, even when not warranted by the facts of any given instance, will perhaps be understandable.

Much time and money have been spent by many scientific men in searching for the true method of making diamonds. Once Sir Charles Parsons, of turbine and telescope fame, carried out many lengthy experiments. Unknown to him at the time, so did Sir Richard Threlfall. Years later the two met. Said Sir Richard to Sir Charles: "Parsons, I don't mind telling you that my diamonds were graphite." Said Sir Charles to Sir Richard: "So were mine!"

—The Editor.

believed that someday science would succeed in what then seemed to the best trained minds in the field to be an impossible task. He determined to conduct experiments along lines which he had



Lewellyn D. Lloyd (*left*) and Dr. J. Willard Hershey. On table (*left to right*): Graphite jar for ice-brine solution, chemically pure graphite crucible, the electric furnace with coils behind it, and power switch

already thought out. He agreed with the views of Moissan that diamonds were made by the compression of carbon, but he believed that he could improve upon the methods of Moissan.

Dr. Hershey outlined a plan of procedure and gave the assignment to senior students working in the chemistry department. The first step in the plan was to secure an electric-arc furnace capable of producing a temperature of 4000 to 5000 degrees, Centigrade—more than twice the temperature obtained by Moissan.

It was soon learned that no such furnace could be obtained from laboratory equipment companies in either the United States or Europe. The use of an oxygen-hydrogen blow torch was next suggested, and the necessary equipment was transferred to a local welding shop for an experiment. However, it was found that the oxygen from the torch burned away all the carbon from the mixture of carbon and iron before the desired temperature could be obtained.

NEXT, Dr. Hershey and his students secured firebrick from a steel foundry and attempted to build their own electric-arc furnace. A neat furnace was constructed, but its first trial proved that its current consumption was too great for the ordinary power lines leading to the college. The equipment was transferred to the municipal lighting plant, where sufficient current could be obtained. Here the furnace was reduced to a glazed mass of molten rock by its own heat. The outlook was very discouraging.

The next five years were spent in gathering equipment and information. At last, a man was found in Chicago who was confident that he could build a furnace of the required type. Special steels were generously contributed by steel companies and after a great deal of work and research, the furnace was completed—a simple affair no larger than a two-gallon pail, but capable of exceeding 4000 degrees, Centigrade. Crucibles and electrodes of chemically pure synthetic graphite were secured for use in the furnace. It was necessary to install a special transformer and a heavy power line, since the power consumption of the

electric furnace was extremely high.

On June 7, 1929, a mixture of two parts of chemically pure iron filings and one part of pure sugar carbon by volume was placed in a graphite crucible, which in turn was placed in the furnace and heated continuously for one hour, seven minutes, after which the crucible was removed and plunged into a freezing mixture.

As white hot molten iron cools to a red solid, it expands. As it cools from a red solid to room temperature, it contracts. Thus the outside surface of the iron, which cools more rapidly than the inside of the mass, is contracting while the inside is still expanding. The carbon which is dissolved in the iron is thus subjected to a pressure estimated at 180,000 pounds per square inch.

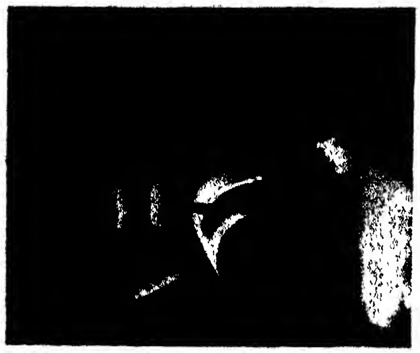
The hardened mass of carbon and iron was removed from the freezing mixture and treated with hot aqua regia for 300 hours to dissolve the iron. The residue, mostly amorphous carbon and graphite, was digested as much as possible in various acid solutions. The search for diamonds was then begun in the black carbon dust.

After two days of searching with microscopes, Dr. Hershey and his assistants received the first reward for their labors. Two stones were found, which, after being tested, were sent to the National Bureau of Standards, at Washington, where they were tested again and declared to be pure transparent diamonds of the first quality. These diamonds, although quite small, were the largest synthetic diamonds on record.

SINCE that time, McPherson College chemistry students have continued the experiments under the guidance of Dr. Hershey, using different forms of carbon, different metals as solvents for the carbon, and different methods of procedure.

Some of the solvents recently used, besides pure iron, are meteorite iron, copper, silver, lead, nickel-steel, manganese-steel, tungsten, aluminum, and blue ground from the South African diamond mines. None of these proved to be so suitable as pure iron filings. Carbon did not dissolve in copper. It took about two hours to melt the tungsten because of its high melting point, and by that time most of the carbon was burned away. No diamonds were formed when lead was used. Rather, the lead and carbon seemed to form carbide of lead. Carbon did not readily dissolve in molten silver. When aluminum was used as a solvent for carbon, some hard crystals having the appearance of diamonds were formed, but these would not withstand the tests to which they were subjected. Probably they were carbide of aluminum.

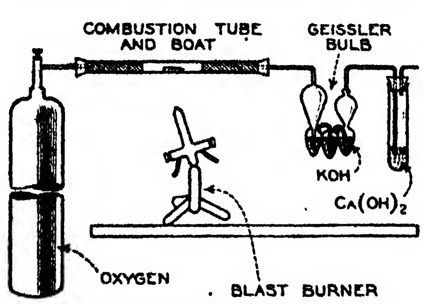
In the diamond mines of South Africa, diamonds are found in a hard blue ground which may have had some part in forming diamonds in nature. With this in mind, some blue ground was obtained from South Africa and used in an experiment as a carbon solvent. This blue ground worked much like iron until it was treated with acid in an attempt to dissolve it. The mass then became as hard as concrete and nothing more could be done with it.


The high-temperature electric arc furnace when in actual operation

Recently, other substances have been substituted for sugar carbon, especially gum arabic, since this has a larger number of carbon atoms per molecule. Coal, wood-charcoal, coke, and other forms of carbon were used, but the most successful has been gum arabic.

An ice-brine solution has been used in most of the experiments to cool the hot molten mass from the furnace, but various other methods of cooling have been tried. In several experiments, the fused mass has been allowed to cool slowly to room temperature, but it appears that rapid cooling is necessary in order to form diamonds. In an attempt to secure more rapid cooling, liquid nitrogen and solid carbon dioxide have been used. Neither was satisfactory. The instant hot molten iron was dropped into liquid nitrogen, the nitrogen changed to a gas, immediately forming an insulating atmosphere around the iron which prevented rapid cooling. When solid carbon dioxide was used it was impossible to secure a surface contact which would cool the iron effectively. Many other methods of cooling have been tried, but none has been as effective as the ice-brine solution.

It appears that it is not the extremely low temperature of the cooling agent which forms diamonds, but rather it is the acceleration of the temperature downward; or, in other words, it is the rate of change of the temperature of the molten iron that determines the pressure and the inner contraction of the iron and carbon mixture.



Laboratory equipment used in the burning test for diamond (see text)

In the nine years since the first diamonds were made, a great deal has been accomplished. The procedures have been greatly improved and shortened. At present the iron from the furnace is dissolved in hot aqua regia. The residue—amorphous carbon and graphite—is digested first in hot concentrated hydrochloric acid with dissolved potassium chlorate, and then in hot concentrated sulfuric acid with dissolved potassium nitrate. Considerable residue still remains. This is washed with water for several days and then searched for diamonds.

Recently a student proposed a new plan which may save a great deal of work. He suggested that, after the residue is washed with water, it be fused with potassium bisulfate, which has a specific gravity between that of graphite and diamonds. This allows the diamonds and a few particles of carbon to sink to the bottom, while the graphite floats on top. After the mass hardens, the diamonds, if there are any, with a slight amount of carbon, can be removed from the bottom of the solidified mass.

THE identification tests used on the diamonds are as follows: insolubility in hydrofluoric acid, hardness, density, index of refraction, and burning in an atmosphere of oxygen. A diamond is insoluble in hydrofluoric acid, although this dissolves most other substances. The hardness of a diamond is tested by scratching on Carborundum. The density is tested in methylene iodide, which has the same density as a diamond (3.51). A genuine diamond will hang suspended in methylene iodide. Diamonds burn in oxygen at 800 degrees, Centigrade.

In the burning test, the specimen is placed in a platinum boat, which in turn is placed inside a silicon tube and heated to 800 degrees, Centigrade, while oxygen is passed in one end of the tube and out of the other end through a Geissler tube containing potassium hydroxide. If the specimen is a diamond it will burn, forming carbon dioxide, which is absorbed in the Geissler tube. A pure diamond leaves no ash in the platinum boat, hence any ash remaining in the boat is positive proof of impurities in the diamond. These impurities are generally metallic oxides and can also be detected by the color of the diamond—a pure diamond is transparent, while impure diamonds are tinted various colors. A number of the smaller diamonds have been burned and most of them left no trace of ash. A number of natural diamonds have also been burned for comparison.

Alpha Ursae Majoris

Recent Research on the Binary Star at the Lip of the Great Dipper Reveals the Orbits of Its Components and Rounds Out Our Understanding of It

By HENRY NORRIS RUSSELL, Ph.D.

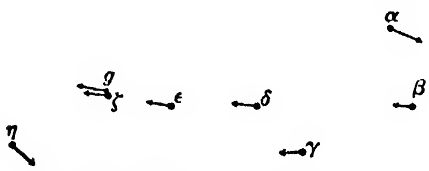
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

EVERYONE knows the Pointers—the stars at the end of the bowl of the Great Dipper whose joining line points (not very closely) to the Pole-star. A careful look at them shows that they are of different colors—the one at the bottom of the bowl, farther from the Pole, is white, and the other reddish. The former, with the other stars of the bowl and handle (except the end), belongs to a well known cluster of stars moving together, distant about 60 light-years. The red star, Alpha Ursae Majoris, is moving in the opposite direction, and is much more distant. The measures of parallax give a value of 0″.022 ± 0.007—which corresponds to a distance of 150 light-years with a margin of error which is as likely as not to be 50 light-years. Despite this uncertainty (which repeated precise measures should diminish) there can be no doubt that this star is really much brighter than the others of the Dipper. Could it be brought to the same distance, it would look about as bright as Capella and would far outshine the rest. Indeed, it has probably about twice the real brightness of Arcturus and considerably exceeds the average for red giant stars.

Almost 50 years ago, in 1889, Burnham, with the great Lick refractor, found that this star was double; it had a companion at a distance of 0″.9, barely visible in the glare of the bright star. From the moment of discovery it was certain that the pair was a true binary, for the bright star is moving in the heavens at the rate of 0″.14 per year, and, if the faint star had not been moving with it, the pair would have been twice as widely separated ten years earlier, and must have been discovered long before.

A FEW years' observations showed that the smaller star was actually moving around the bright one. By 1902 its direction from the primary had changed more than 50 degrees, while its distance diminished, until it became almost impossible to see. Then, despite careful watching by the best observers with the greatest telescopes, nothing more was seen of it for 30 years. Finally, in 1933, Aitken, again with the Lick telescope, saw and measured it once more, very close to the position in which it was discovered. In the 44 years it had completed a revolution; but for most of the time it had been lost in the light of its great neighbor. Since then it has been regularly observed retracing the same path which it followed in the 'nineties.

Were it not for the close proximity of the bright star, the companion would be easy to see. The only *measures* of its brightness were made by Kuiper in 1933, with an ingenious device by which a small and measurable fraction of the light of the bright star could be diverted into a subsidiary image, which could be set at any desired distance from the principal one. By putting this image at the same distance as the real companion, so that the effect of the glare was the same for both, Kuiper found that the companion was of magnitude 4.9, or 1/15 as bright as the primary. The earlier observers had estimated it as very much fainter—of the 9th, or even the 11th magnitude. But these estimates really describe how hard the companion was to see—allowing, by a sort of well-trained guess-work, for the effect of the glare—and the recent measures are, of course, far more reliable. If, then, the companion stood alone, it would be easily visible to the naked eye. It is by no means an inherently faint object. With this assigned distance, its real luminosity comes out 19 times that of the Sun, and that of the primary 280.



Courtesy Ginn and Co

Ursa Major, showing direction of proper motions and amount in the past 50,000 years. From Russell, Dugan and Stewart's "Astronomy"

When a double star has been followed for a complete revolution, it is usually easy to calculate its real orbit. The observations give the apparent orbit of the companion about its primary, but, since the true orbit is usually not seen in plan, but more or less edgewise, allowance must be made for this foreshortening—which can be done in a couple of hours' calculation. But, in this case, the companion was unobservable for more than three quarters of its track. There was no doubt about the period, but only a small part of the apparent orbit could be drawn—not enough to be sure about the rest.

The difficult problem thus presented has been solved by Dr. H. Spencer Jones—the Astronomer Royal—and Mr. H. H. Furner of the Greenwich staff. Two other sources of knowledge were available—the meridian observations of the star, and the radial velocities.

Since Newton's day it has been known that, in such a pair, the center of gravity of the two stars moves uniformly, while the two stars describe orbits about this point, keeping on opposite sides of it. Accurate observations of the right-ascension and declination of the principal star should therefore show, in addition to the uniform motion, a regular oscillation, repeating itself in a period of 44 years. By good fortune this is one of the "clock-stars" which are regularly observed as standards, so that thousands of observations have been recorded and published, dating from 1806 till the present time.

TO eliminate various possible errors, the observations of Alpha Ursae Majoris were compared with those of a number of other bright stars, taken at the same observatory and with the same instrument. Each particular set of observations gave values differing slightly from those calculated with the aid of Boss's Catalogue—the differences arising partly from instrumental errors and partly from real causes. By taking the difference between the discordance for Alpha Ursae Majoris and the others, a great part of the instrumental errors was cleared out. In this way 114 positions in right ascension were obtained, and 96 in declination—each representing the mean of a large number of observations. When these were plotted, after allowing for uniform motion, a wavy displacement, with a period of about 44 years, was clearly shown.

Courtesy *Princeton Alumni Weekly*

The 23-inch refracting telescope within its observatory dome at Princeton University. The objective lens is one of the famous Alvan Clark's unexcelled (in fact, unequalled) creations, but the mounting is a recent one by Fecker. The objective was designed for visual use. In a telescope designed for photographic use, varieties of glass having different compositions are selected from which to make the two lenses of the objective, also their surfaces are given curvatures, such that the shorter wave-lengths—violet and blue—because these are the most photo-sensitive, will be brought to the same focus. For visual work such a telescope is, however, practically useless, and the aim is to bring the whole gamut of rays from the violet to the red, as nearly as possible to one focal distance

As the bright star moves around the center of gravity, its velocity of approach toward the Sun must change. A long series of observations at the Lick Observatory, for the last 40 years, were available—partly from previous publications, partly sent to Greenwich as a friendly contribution to the work. They, too, show a slow oscillation, running its course in about the 40 years covered by the observations. By combining these three sets of data, Jones and Furner—after a skilled and laborious study—have succeeded in calculating an orbit which represents all the data.

The mean distance of the stars in the true orbit is 0".63, corresponding, with a parallax of 0".022, to 29 astrononomical units, or a little less than Neptune's distance from the Sun. The eccentricity of the orbit is 0.35 and the inclination to the "plane of the sky" is 18 degrees. The stars were closest together in 1910, and are at present returning from their maximum separation. Since the inclination is small, the range in radial velocity is also small—only two kilometers a second on each side of the mean value.

With the period of 44 years, the combined mass of the pair comes out 12.4 times that of the Sun. The mean distance of the bright star from the center of gravity is 0".196, 31 percent of this separating the components. It follows that the mass of the companion is 31 percent of the total, or 3.8 times the Sun's, while that of the principal star is 8.6. Both these values are in good agreement with Eddington's relation between mass and luminosity, which is thus once more confirmed, though with no great accuracy, as the parallax is too small to be directly measured with high percentage accuracy.

This fine piece of work leaves this star one of the best known in the heavens—and one of the most interesting. It is the first red giant star (Class K0) for which we have a visual orbit, and a directly measurable mass. The only other giant for which we have these is Capella, which is of Class G0, at the very end of the sequence of giants, while Alpha Ursae Majoris is in the middle.

ASSUMING, with Jones and Furner, a surface temperature of 4000 degrees, we find that the bright star should give out one eighth as much light per square mile as does the Sun. Being 280 times as bright as the Sun, its surface area would be 2200 times as great, and its diameter 47 times the Sun's—as big as Mercury's orbit. Its volume is 100,000 times the Sun's, and its mean density 1/12,000 the Sun's or a little less than one tenth that of air under standard conditions. These are just such values as we now expect for a giant star, but the direct confirmation is nevertheless important.

The companion, with its mass nearly four times the Sun's and its visual brightness some 20 times, is very far from being a dwarf star. Jones and Furner consider that it is probably itself a giant star, of spectral type much like the primary, but perhaps a little redder. It would be considerably fainter than the average giant star, but would fit very well with the fainter group called by Strömberg the sub-giants. The only objection that could be raised to this is that, when a red giant star has a companion, considerably fainter, far enough away to permit its spectrum to be observed separately, the companion is almost always of early type (Classes A or B). A hot star of the same mass would be brighter visually, and fit the observed data less satisfactorily—though perhaps within their limits of error.

Whether the companion is actually of early or late spectral type might be determined by photographs of the farthest accessible ultra-violet end of the spectrum. If the companion is of Class K, like the primary, its spectrum would be completely drowned out; but if, like that of Zeta Aurigae, it turns out to be of Class B, it should be as strong as the primary.

Such observations, and also additional series of measures for parallax, should add a little more to our information regarding what is already one of the best-known systems in the sky. —*Chamonix, July 1, 1938.*

Fish Over a Dam

Bonneville Dam...Many Novel Features...Generates Power...Extends Inland Waterways...Greatest Fishways...Fish Can Go Upstream or Down

By R. G. SKERRETT

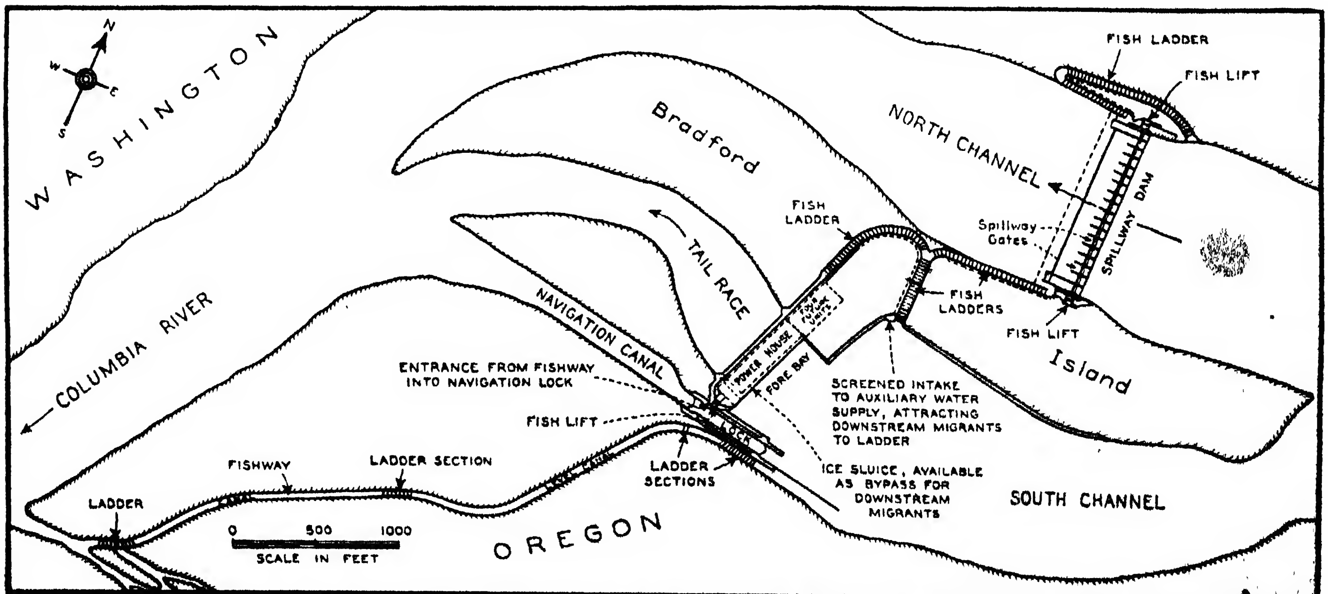
SAFEGUARDING the salmon fisheries of the Columbia River system: generating more power from the seaward flow of the main stem of that magnificent stream; and extending the inland penetration of deep-sea shipping constituted the threefold problem that had to be solved in the planning and the building of the Bonneville Dam, lately completed.

Probably the protection of that river's historic salmon fisheries is the aspect of the undertaking that makes the widest popular appeal, because the Columbia is said to be the greatest of the salmon-producing rivers in the United States. Quite apart from self-interest in what salmon from that source have contributed to the satisfaction of our palates and to our physical well-being, the catching, packing, and otherwise processing of salmon have netted those engaged in the industry an annual return of about $10,000,000. Because the Bonneville Dam is strategically placed at the uppermost reach of tidewater on the Columbia, that structure occupies a key position in the path followed by perhaps 75 percent of the salmon in their accustomed migration to and from the sea. To halt or seriously to reduce those movements would directly affect the gainful employment of more than 21,000 persons. The aquatic biologist, other fisheries experts, and the engineer were therefore called upon to pool their knowledge and experience, and, with the further aid of research, to devise man-made facilities that would lure the salmon to new lines of travel past the dam, despite the interposition of that barrier.

Even at low stages, the Columbia River has a large volume of flow; and because of the snow-clad mountain sources of most of its water, the volume at flood stages is enormously increased. Nevertheless, ocean-going ships have not heretofore been able to ascend the river higher than Vancouver, Washington, 103 miles inland from the Pacific, or to Portland, Oregon, on the tributary Willamette River, 114 miles in from the sea. Those two ports, however, have a maritime commerce of fully 6,000,000 tons annually, with an estimated value in excess of $300,000,000. Above Vancouver, and within the tidal section of the river, light-draft vessels have moved yearly about 2,000,000 tons of freight; barges have been operated heretofore for some distance above the site of the Bonneville Dam, carrying in the course of a year approximately 85,000 tons of freight valued at more than $1,500,000.

BONNEVILLE Dam is 144 miles above the mouth of the Columbia and about 41 miles upstream from Vancouver. At an outlay of $2,300,000, a channel 300 feet wide and 27 feet deep at low water will soon be available throughout that stretch of the river. Above the dam, for approximately 50 miles, there is now ample depth of water for steamships of large capacity to continue on to The Dalles, nearly 190 miles from the sea. The improved route for shipping will lead to an annual carriage of possibly 2,300,000 tons of freight, which it is estimated can thus be transported at a saving of 40 cents a ton.

Unquestionably, the prime reason for the Bonneville project is the generation of hydro-electric energy to be sold at a notably low price, first to benefit a largely rural and agricultural population and then to serve existing communities within economical distributing distances. Eventually, cheap power is counted upon to draw a variety of industries to the region, on both the Washington and the Oregon sides of this boundary river. At the present time, the power plant is equipped with two main generating units, their turbines developing an average of 60,000 horsepower each. As the demand for current increases, additional units will be installed until the group numbers a total of ten; and at certain



General plan of the Bonneville Dam power-navigation project. Note especially the various fishways

stages of the river those turbines will have a combined output of 660,000 horsepower.

It should be recalled that Bonneville Dam is at the downstream end of a stretch of the river within which it is expected that ten dams will some day utilize to the utmost a drop of nearly 1290 feet between the Canadian boundary and Bonneville. With all ten plants provided with their designed maximum number of units and making full use of the river's abundant flow, the numerous turbines will be able to develop in excess of 11,000,000 horsepower! Well may the Columbia be called a wonderful river and the neighboring region exceptionally favored in its power potentialities.

The Bonneville development is composed principally of four distinctive features: a spillway dam that spans the main or north channel of the river; a second dam and combined power house, which blocks the lesser channel of the river (Bradford Island standing between the two dams); a large ship lock along the south side of the power house and contiguous to the Oregon shore; and a number of fishways, of two different designs, located at various parts of the dams where the migrating fish may seek passage, when bound either upstream or downstream, as habit urges them.

To Aid an Important Industry

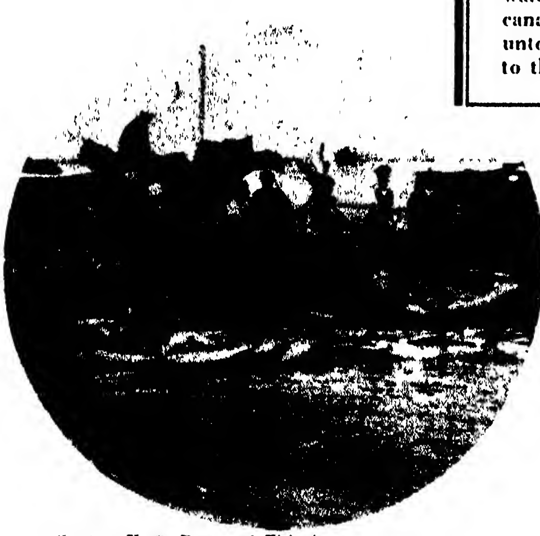
THE Bonneville Dam will prove to be a blessing instead of a curse to the fisheries of the Columbia River.

This statement is so challenging and so contrary to common belief that it bears examination. Bonneville Dam, located on the greatest salmon-producing river in the United States, is a 70-foot barrier of steel and concrete which must be surmounted by a large portion of the salmon runs seeking their ancestral spawning grounds in the upper tributaries of the Columbia, throughout Oregon, Washington, and Idaho. Failure to surmount this dam will destroy a 10-million dollar fishery.

Before the dam was built, however, the Columbia River fisheries were undergoing progressive depletion. The commercial fishery in the lower estuary of the river and at sea always takes a heavy toll from the stock, and those fish that escape this hazard encounter many minor dams used for power, irrigation, and other industrial purposes throughout the watershed. Many of them prevent the access of fish to their spawning areas. The waters of the river are also used for irrigation, and many tributary streams have dried up during low-water periods. Many of the irrigation canals are still unscreened and carry untold thousands of young salmon to their death in the fields. The pollution of streams by mining and manufacturing wastes, the erosion of deforested hillsides, and changes in the river course still further restrict the productive capacity of the Columbia River watershed. All of these conditions must be corrected.

The last session of Congress authorized an appropriation of half a million dollars to enable the Bureau of Fisheries to perform this task. Such action may never have been taken had it not been for the impressive dramatization of the hazards to Columbia's salmon by the construction of Bonneville Dam; hence the dam is a blessing!

Adult fish are using the Bonneville Dam fishways without delay, and young salmon are finding their way downstream through special fingerling passes. Accurate counts of each species of fish passing through the fishways are kept by trained enumerators. Now, for the first time, the number of fish caught by the commercial fishery and also the number passing Bonneville Dam to reproduce will be known. A system of bookkeeping can, therefore, be established that will show year by year the available balance of Nature's legacy held in trust for the future under the stewardship of the State and Federal Governments.—*Frank T. Bell, U. S. Commissioner of Fisheries.*



Courtesy U. S. Bureau of Fisheries

Salmon catching on the Columbia

The spillway dam has an over-all length of 1250 feet; between the terminal abutments, the intervening space is divided into 18 passages or bays by a succession of massive piers, spaced equidistant, which support 18 steel vertical-lift gates. All the gates are 50 feet wide, but 12 of them are 50 feet in height while the three flanking ones at each end of the spillway are 60 feet in height. When closed, or resting on the crest of the spillway, the gates will hold the pool above the dam at its maximum normal level, which is 82.5 feet above the sea; the gates will be raised to different heights, to let water run beneath them over the spillway, to regulate the level of the pool according to the volume of the stream's flow. At exceptional flood stages, all the gates may have to be raised to their full extent to let the excess water move with a maximum of ease on its course to the sea. The discharge of the river past the dam site may range from 40,000 cubic feet per second to a recorded extreme of 1,170,000 cubic feet per second. The ordinary rise and fall of the river between low water and high water is 21 feet, but the extreme fluctuation may be as much as 47 feet. This explains why the spillway has so many and such large gates, because they serve both to impound water and to act as safety valves under flood conditions.

The normal operating head at the water wheels is 66 feet, and the plant is classed as a low-head one in hydro-electric practice; but because of the marked fluctuations in the level of the river and the great extremes in volume of flow, the engineers adopted the Kaplan type of turbine, in which the angle of the blades can be changed to make the most satisfactory use of the water delivered under any condition of the river at the dam site. Each of these water wheels has a diameter of 23 feet four inches, and is of much greater power than similar units in service elsewhere. Each turbine drives an electric generator rated at 48,000 k.v.a; both the water wheels and the electric generators are engineering achievements of an outstanding order.

THE ship lock has a chamber width of 76 feet and a length of 500 feet; and the depth of water at the lower sill, or entrance, is not less than 26 feet. The lock is a single-lift structure, and at one operation can lift or lower a craft through a maximum vertical distance of 67 feet—an extraordinary performance.

The Columbia River is frequented by four species of salmon and by the steelhead trout, of which the chinook salmon is the most important. All these fishes spawn in fresh water, but spend most of their adult existence in the sea. Female steelhead trout are known to return annually over a period of several years to fresh water to reproduce their kind; but the full-grown salmon makes but one run from the sea to its fresh-water breeding ground, and dies shortly after spawning. The eggs are deposited in the gravel of the chosen spawning bed, and hatch in the course of from two to

rtesy Chief of Engineers, U S Army

ooking westward (downstream) from above Bradford Island. These fish ladders are on the is-nd between the main dam (not visible—at right) and the power house at the extreme left

four months. Some young salmon migrate seaward shortly after hatching, while others may remain in fresh water a year or more before making their way to the ocean. The young salmon, commonly known as fingerlings, are from three to six inches long by the time they issue from the mouth of the Columbia. After reaching the Pacific, the salmon wander in schools in quest of plankton organisms and the small fish upon which they thrive; they grow rapidly during their stay in the sea, which, depending upon the species, may be from three to six years. While in the ocean, some Columbia salmon journey as far northward as the waters of Alaska before returning to the river to complete their life cycle. On their run up the Columbia, perhaps hundreds of miles, the fish do not feed but utilize the energy stored up in their fat, matured bodies to carry them back to the spawning area in which they were hatched. This urge is so strong that the fish may exhaust themselves and perish if untoward conditions hamper their progress.

SALMON invariably travel water courses swept by fairly strong currents, and the force of the current has a guiding influence in leading the salmon, going up or down river, to paths favorable to their advance. This well-known fact had to be given due consideration in planning the fishways at Bonneville. Salmon of one species or another are ascending the river almost continuously from about April to December of each year. On the other hand, the young of some of the species are found on their oceanward migration virtually throughout the whole year. Therefore special fingerling passes are provided at the Bonneville Dam: one at each end of the spillway and one at the south end of the power house—the latter connecting with the ice chute and receiving an overflow from the entire face of the power-house dam. The fingerlings may even descend through the spacious draft tubes for the turbines with comparatively little risk of injury in going by the water wheels which make only 75 revolutions a minute.

The mature salmon, bound upstream, present a radically different problem in getting them safely past the dam. Full-grown chinook salmon may weigh as much as 70 or even more than 100 pounds, but the average is 22 pounds. The blueback salmon may range from two pounds to six pounds in weight, and be from 16 to 22 inches in length. The steelhead trout may weigh as much as 30 pounds; neither the adult salmon nor the steelhead trout can ascend through the overflow water at the spillway.

Extensive experiments made separately and conjointly by the Army engineers, fisheries experts of the states of Washington and Oregon, and the United States Bureau of Fisheries furnished the basic data for the fishways built at the Bonneville Dam. In that way was obtained reasonably precise information about the velocities, eddies, and the turbulence of the natural water courses threaded by salmon and steelhead trout en route to their different spawning beds; it was thus possible to devise for Bonneville artificial settings that would subscribe to the inherent requirements of the fish, lure them, and then get them up and over the dam without exhausting them. The fish are attracted to the fishways by maintaining at the entrances of them outflowing streams of water having velocities such as those against which salmon and steelhead trout are accustomed to swim.

The structures at Bonneville are too complicated for a detailed description here, but in the main they consist of four fish ladders, three collecting traps, and three sets of double fish locks or hydraulic lifts. Each fish ladder is a walled channel or sluice, with transverse partitions of suitable height and proper spacing to create a succession of stepped pools, each 16 feet long and with a drop of one foot between its adjacent pools. Each ladder is about as wide as an ordinary four-lane highway; there is thus assured ample depth and plenty of room for many thousands of salmon to work their way up and over the dam daily through any one of these so-called ladders. At each end of the spillway, on the downstream side, there is a collecting trap so arranged that the fish can enter easily but are checked from retreating afterwards. These traps connect directly with their respective fish ladders; their primary function is to draw the fish to them by discharging streams of agreeable velocities and, in

Courtesy U S. Bureau of Fisheries

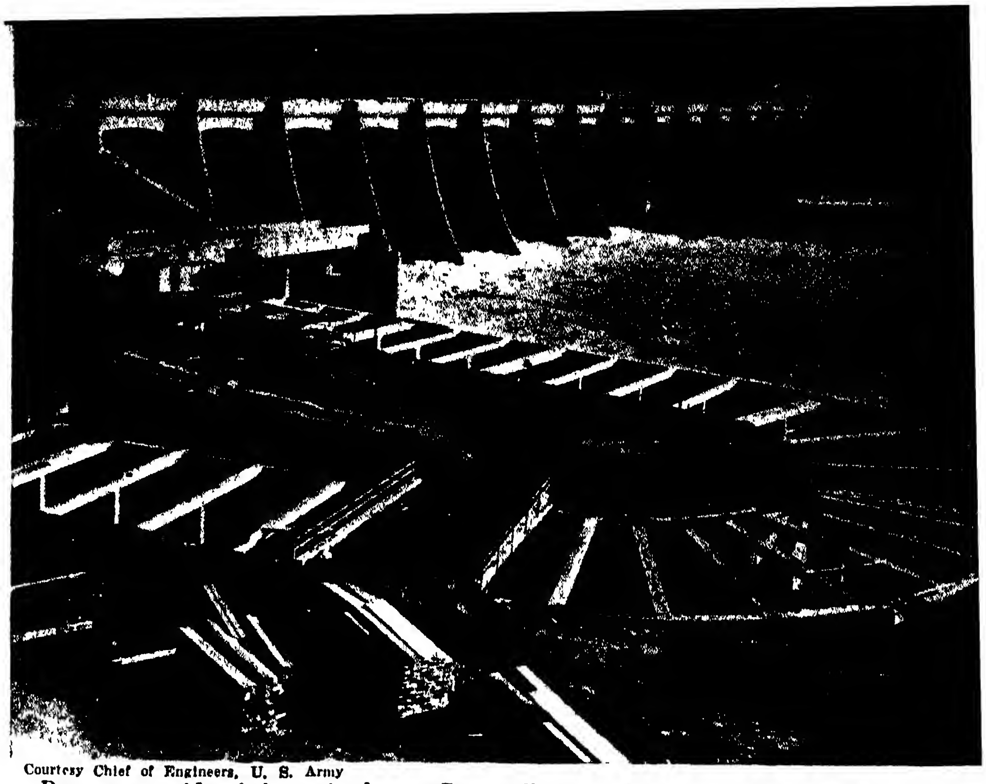
Fine adult male blueback salmon in spawning condition, caught by a government expert

that way, discouraging the fish from exhausting themselves by battling with the higher and much swifter spillway overflow. The collecting traps are so placed that the fish after once entering them can make use of either the ladders or the nearby hydraulic lifts.

On the downstream face of the power house, and built into that structure, there is a much larger collecting trap. That trap leads to a fish ladder at the

north end of the power house, while at the opposite end the trap affords the fish admission to a lift lock or to the neighboring ship lock. In any case, the great collecting trap is designed to draw the up-bound adult fish away from the turbine draft tubes and to make it possible for the fish to reach the pool above the dam and to continue thence to their respective spawning areas.

In simple terms, the hydraulic lifts are large rectangular shafts, with reinforced-concrete walls, which have openings, at various levels, both for the admission and the escape of the fish. These passages can be opened and closed as required; and sufficient water is admitted to a shaft to carry the fish from the intake level up to the pool level—a movable grating floor rising beneath the fish and causing them to flee from the shaft at the proper time. The column of water in each of the twin shafts is alternately raised and lowered to transfer succeeding lots of the fish.



Courtesy Chief of Engineers, U. S. Army

Downstream side of the main dam at Bonneville, viewed from the north, or Washington, side. U-shaped canal in foreground is the concrete channel of the northernmost fish ladder

THE fishways at Bonneville Dam have cost about $6,553,000; the installation stands unique in its diversified and rounded features. It is undoubtedly the greatest thing of its kind reared anywhere up to date. The success of these fishways is a matter of world-wide interest, and it is recognized that they constitute an immense experiment which may be a conclusive solution of one aspect of our problem of food supply.

In designing Bonneville Dam, provision was made simultaneously for the incorporation of fishways; during the actual construction of the dam care was taken to leave ways open for the upstream and downstream migration of the salmon and steelhead trout, so as not seriously to disrupt their established habits. In the case of the Grand Coulee Dam, also on the Columbia River, the ultimate height of that structure and other circumstances will make it economically impracticable to provide fishways there. The number of salmon and steelheads normally spawning above the site of Grand Coulee Dam is not believed large; and the Government experts estimate that only 3.5 percent of the total run of spring chinooks, 13 percent of the bluebacks, and but 1 percent of the steelheads ascend the river above Grand Coulee. A passage still remains in the Grand Coulee Dam through which the fish can move up- and downstream, and other provisions will be made to compensate for these movements when that opening is closed.

The solution proposed by the qualified authorities is to capture the fish on their spawning runs at the existing ladders in operation at the Rock Island Dam, which is about 150 miles downstream from the Grand Coulee Dam. The adult fish will then be transferred to holding ponds on the Wenatchee River and Icicle Creek—tributaries of the Columbia—where the fish will be kept until they are ready to spawn. Spawning will be induced artificially in accordance with the usual hatchery procedure, and the young will be planted in tributary streams that have their confluences with the Columbia at points between Rock Island and Grand Coulee. Experiments have disclosed that mature salmon have an instinctive urge to return to the waters in which they were hatched—not necessarily to the original place of spawning. It should, therefore, be possible to change their habits so that the fish that have heretofore worked their way to the waters above the Grand Coulee site will, in succeeding generations, establish themselves in suitable streams that will be accessible to them below Grand Coulee Dam. Only time will reveal whether this can be done, and at a compensating cost.

Whatever doubts may have been entertained concerning the probable usefulness of the fishways at Bonneville Dam were completely dispelled by the action of the salmon during their upstream migration last spring. During that migration, trained checkers counted the fish passing upstream for several weeks. While their early reports showed a relatively small number over the Dam, indications are that the run was smaller than usual, for at no time was there any congestion of fish at the foot of the Dam. There is no question that the salmon made the fullest use of the fishways, and it is believed that what has been done at Bonneville emphasizes the possibility of protecting valuable fisheries in other inland waters.

A steelhead trout leaping up and over a cataract on the Columbia on its way to its spawning area. In this way both trout and salmon surmount fish ladders

Courtesy U. S. Bureau of Fisheries

ELECTRICAL RHYTHMS

From What Abysm of the Human Brain Come These Electrical Pulses, Our Brain Waves? Puzzled but Deeply Intrigued, Science Seeks Their Meaning

(In Two Parts—Part One)

THE discovery of a new phenomenon, particularly of the brain, may have so unexpected a character as to be long incredible to seasoned investigators. In 1928, Dr. Hans Berger, of Jena, reported that it is possible to show and record a quite strange electrical rhythm of the human brain. Scepticism endured for years, so great were the implications of his report.

Electrical waves surging from the brain! What true scientist could conceive of such a phenomenon?

At last, however, repeated confirmation by eminent physiologists proved beyond doubt: The Berger rhythm is a reality, and immensely important.

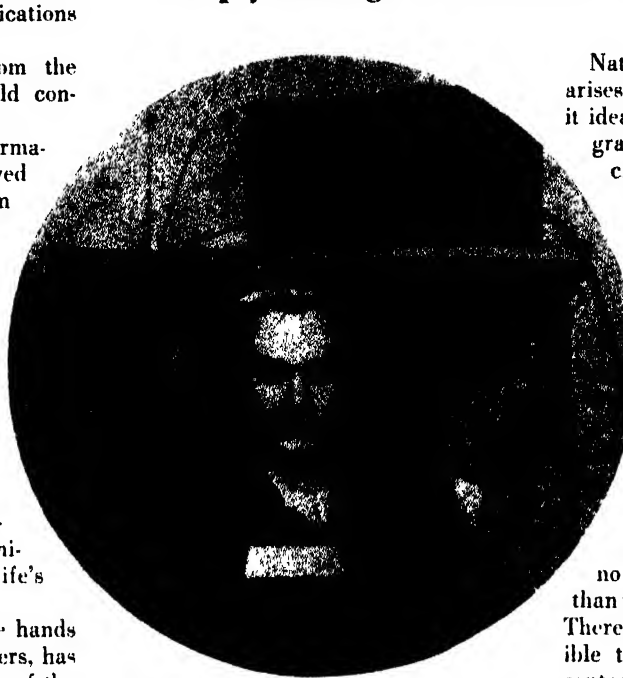
Borrowing a vacuum tube, Berger built an amplifier powerful enough to magnify weak electric impulses a millionfold. Adrian, the great English physiologist, explains that such a superlatively sensitive aid as the electric amplifier means as much in the detection of life's physico-chemical activity, or physiology, as the invention of the microscope in the detection of life's architecture, or anatomy.

This powerful amplifier, in the hands of Berger and later of many others, has disposed of the old, static picture of the brain. Today, a motion picture of the true, the dynamic, brain can be exhibited as a fascinatingly novel mystery, far grander than the old. And already features of this cinema are being practically applied to common but heretofore completely baffling medical problems, such as epilepsy, man's fitful malady. New clues there are to insanity, too.

BERGER attached his radio-like amplifier to a living human head. As his subject became calmer, a phenomenon leaped into scientific records. Pulses of electricity, shooting out from the gray matter inside, pierced skull and scalp. These waves beat out a rhythm in the detector, and the concept of the ever-restless brain was born.

In a simple, sample hook-up, two wires run out from the amplifier. At the end of each wire is a contact point, or electrode —often a pad moistened with salt solution, so that intimate electric contact is effected between wire and scalp. One electrode may be fixed by paste to the skin of the high forehead, and the other to the scalp at the back of the head.

Through these contacts and their wires, the brain-induced electricity is sent to the amplifier, which magnifies the delicate rhythm. The amplified surges can then be made to operate a pen which



Courtesy Brown University

From electrodes on the subject's head, wires lead to an amplifier and the output of this is made observable in one way or another

traces the waves on moving paper tape. The tape slides past at a steady rate—a few feet per minute—and upon it a second pen, part of an electric clock, notes the seconds. Thus, the count of waves per unit of time is accurately told off before the eye, and thus the Berger rhythm of the living human brain becomes a clear record in black and white.

In other hook-ups, several sets of electrodes and of amplifying devices are used to give simultaneous recordings of the waves from different portions of the brain—the contacts are variously placed on the scalp. Further, some amplifiers use an oscillograph in which a light beam is used as a pencil to write the wavy record upon a moving photographic film. Also, the cathode-ray oscillograph can be introduced to cast upon a small screen a visible, immensely magnified, standing undulation representing the electrical state of affairs below the scalp at a given moment.

Whatever the hook-up, the assemblage of instruments is an electro-encephalograph. And the record—tape or film—is an electro-encephalogram, or E. E. G.

Naturally, since the Berger rhythm arises from the brain, investigators find it ideal to place the contacts as near the gray surface as possible—best precisely on the brain's gray coat, or cortex. There are, however, no reports of human heads being broken for such research.

But needle contacts have been used, infrequently, instead of moist pads, and made to penetrate the scalp and meet the bone. Thus, slightly stronger waves are drawn off. Once or twice, brains exposed through injury have been available, and still stronger waves recorded.

Still, rhythms so obtained have no greater regularity of occurrence than those obtained from the intact scalp. Therefore, in the main, it has been feasible to use intact human heads, with contacts merely stuck to the outside—though shaven spots approximately the size of a cent are usually considered indispensable aids to research.

GUINEA pigs, rabbits, cats, dogs, and other creatures exhibit similar rhythms. Hence physiologists are not too impatient for the next great war's magnificent production of experimental material.

The electric pulses from the surface of the brain—that is, from the cortex, gray layer of nerve cells—constitute a comparatively strong rhythm, called the "alpha" rhythm, with a beat of about ten waves per second in man. There are, besides, other oscillations from deep within the brain. Concerning these more rapid and far weaker, almost undetectable waves, little is yet known. Surely, however, from the deep, central portion of the brain emerges the constant electric chugging known as "beta" waves, with a frequency of 25 to 30 waves per second. At present, when brain waves are popularly spoken of, alpha waves are almost invariably meant.

In the instance of the alpha waves, Berger points out the necessity for the complete exclusion of outside stimuli—if successful recording is the aim. The work of others, however, shows that outside disturbances do not invariably in-

OF THE HUMAN BRAIN

By BARCLAY MOON NEWMAN

terrupt the rhythm, though the waves are usually interrupted or abolished by light on the eye, by embarrassment, anxiety, and intense mental activity, as in the attempt to solve difficult problems in a hurry.

Hence, in ideal experimentation, the subject is induced to sit or lie down, and to relax, in a dark room—despite the fact that the rhythm generally appears anywhere and at any time, when a person merely closes his eyes.

The subject has been calmly resting in the dark for only an instant. The waves start up. They appear in broken series, or wave "trains" with brief intervals in between. Generally they run through their rhythm in from 1 to 30 seconds, and stop, only to start again after a minute or two.

To human vanity, the recorded rhythm looks too simple to come from that vast and intricate fastness, the human brain. Very similar waves may be produced if you take a pencil and draw a wavy line between two points three or four inches apart.

A light shone in the eye almost invariably puts an end to the waves. But persons have been found who readily exhibit alpha waves even when illumination is striking the open eye, though their waves are stronger in the dark. Besides, any one will weakly manifest the phenomenon during exposure of the eye to light—provided that he has been lying quietly at rest for more than two hours.

Adrian predicted that blind people would not have the Berger rhythm. And he could find no rhythm in three blind individuals. Investigators Loomis, Harvey, and Hobart, however, demonstrated that the blind do show the waves. Adrian's subjects were undoubtedly ill at ease.

Many persons, before becoming accustomed to the electrodes and to the laboratory environment, do not have alpha waves. It may be an hour or two before the subject overcomes his mental unrest and permits his brain rhythm to appear.

A relaxed subject, showing strong waves, is given a difficult mathematical problem to solve quickly by purely mental effort. The resultant mental unrest largely inhibits, or wholly destroys the waves, as does any intense concentration. But poetry can be recited, or simple problems worked, or skilled hand movements performed, and the waves continue.

Two subjects, who usually had "good" waves, for a time had "poor" waves. Tactful inquiry elicited the information that, in one case, an important football game —no less—was approaching; in the other case, a secret engagement was playing havoc with the Berger rhythm.

An excessively self-conscious subject or one who is in some way embarrassed is likely to yield waves only spasmodically if at all, under experimental conditions. Loomis, Harvey, and Hobart mention a person who can abolish his waves by self-inducing a "phantasy of fear." The same workers remark upon the seemingly spontaneous interruption of the waves every few seconds. Are there periodic surges of emotion welling from some abysm of the brain? Here is an unknown. Or does an individual every few seconds become more alert, more tense, so that the waves are interrupted? A sudden loud noise, or any startlement, abolishes the undulation. And the stimulus of pain, suddenly felt, kills the phenomenon. Finally, deep anesthesia or normal slumber can make it sleep.

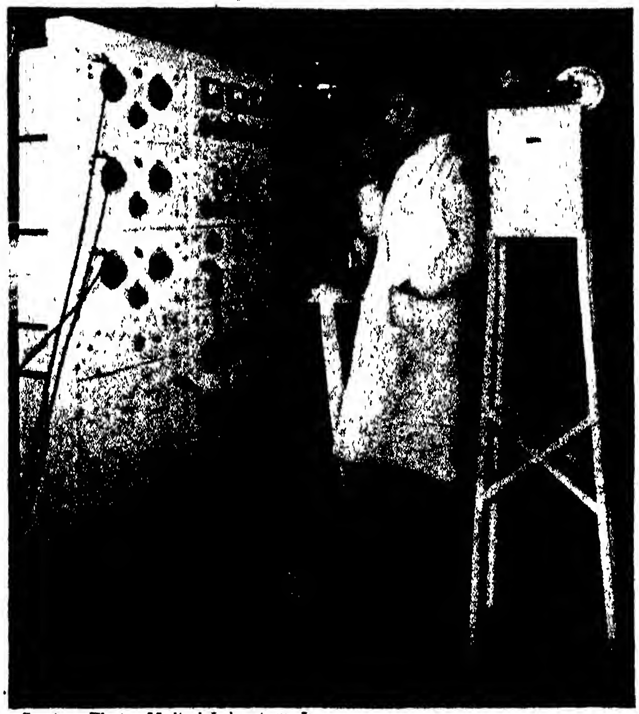
A REMARKABLE experiment is the conditioning of the response to light. The subject is sitting relaxed in the darkened chamber. His alpha waves are blithely writing their record with pen and ink, or with luminous pencil. So that the subject will not be startled, he is forewarned: then a bell is tapped. Unaffected, the vibrations continue on their happy way across the moving tape or film.

But now, several times in succession, simultaneously tap the bell and flash a light upon the subject's open eyes. At each flash, as we expect, the rhythm dies; and, a fraction of a second after the renewed descent of darkness, it comes to life again.

Following the association of flash with sound, tap the bell, but do not flash the light. Immediately, as though light struck the retina, the vibrations halt. From now, and for some little time, the association of light with sound endures within the brain, for sound alone can kill the waves. The response of the subject has been temporarily conditioned.

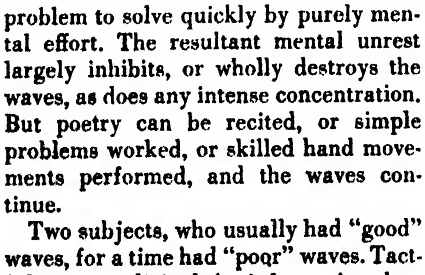
Further, Loomis, Harvey, and Hobart have, interestingly enough, looked into the matter of hypnotic "blindness." Temporary "blindness" can be induced by hypnotic suggestion, after a subject's eyes have been fixed open by means of adhesive.

"You are blind," the hypnotized subject is told, and whether or not light is



Courtesy Electro Medical Laboratory, Inc.

A three-channel, integrating electro-encephalograph. To localize the point of origin of the electrical waves generated by the brain, trace their progress, and map out the pathways of the nervous system, several separate amplifying systems are operated simultaneously, using electrodes on different parts of the head. Three sets of waves, like those shown below, show on oscillograph screens at breast height and may also be photographed by continuous-record automatic camera at right. Below, at center, is a short series of alpha waves from the cortex—beginning small, increasing, diminishing (spindle)



Courtesy Brown University

Prof. H. H. Jasper of Brown University and Prof. Leonard Carmichael of the University of Rochester viewing an oscillograph showing typical brain waves

shining in his eyes, alpha wave trains come along.

"You are not blind. You can see," it is next suggested. Each time such a suggestion is made, the waves cease, even amidst complete darkness.

And—equally remarkable—as these three physiologists discovered, the alpha rhythm of an unhypnotized subject in a dark room disappears upon the suggestion that he sees a light or a face. But trains cannot readily be started in a subject, unhypnotized and with his eyes open to light, when it is suggested that he cannot see.

IN the same series of studies, "hypnotic sleep"—the state of hypnosis—and normal sleep were compared. Observation showed that, when a person is falling asleep, the alpha waves become gradually less frequent, and finally subside. In deep sleep, a new type of wave train appears: "spindles," so called from the record which they leave—the record or imprint of a spindle-like wave-train tapers at both ends. That is, the spindle is made up of a series of waves, whose height, or amplitude, gradually increases, reaches a maximum, and finally decreases to zero. All of the waves in a single spindle—about 14—arrive within somewhat less than a second. One spindle follows another during deep sleep, and are so characteristic of this state that their appearance is now accepted as a demonstration of the maximum in slumber. Certain random waves also occur during sleep.

A subject in whom the hypnotic state has been induced, however, and who exhibits the typical, sustained cataleptic rigidity, has the wave trains of a person wide awake. No spindles and no random waves appear. Loomis, Harvey, and Hobart conclude that, applied to the hypnotic state, the term "hynotic sleep" is a misnomer.

Subjects thus have learned to fall asleep with electrodes attached to their heads. The wires are led into an adjoining laboratory and there plugged into the amplifier. As the subject slips into deepening slumber, the waves subside gradually. Spindles and random waves

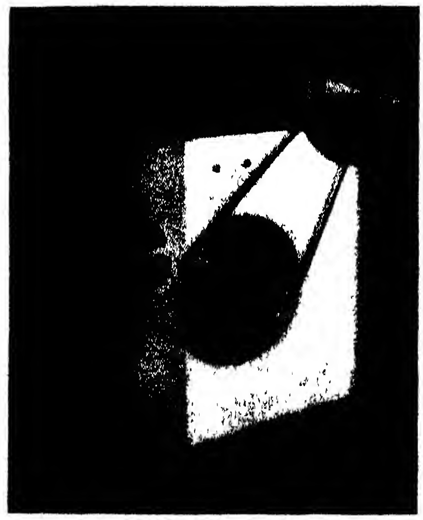
Electro Medical Laboratory, Inc.

A clinical electro-encephalograph of the kind that records waves by means of an ink-writing oscillograph

finally replace the erstwhile rhythm. If the individual is gently awakened, the rhythm returns.

The honking of automobiles has no effect upon the sleeping subject who is accustomed to such noise. Even the slamming of a door may go unrecorded on the tape or film. But let there be a whisper, or a rustling of paper, or stealthy footsteps—less noise, it is true, but somehow more suggestive noise. At once the wave trains come scurrying along. Is this a newly found vestige of our prehistoric existence? The sign of an innate, ancient fear of stealthiness near at hand? Perhaps some secret sentry, quick with primitive emotions, is alert, and nudges the higher command: "Hark! What beast skulks close by?"

One martyr allowed himself to be kept awake for more than 50 hours. Hence, he was able to fall asleep almost instantly. Each time he fell asleep, his alpha waves vanished. Prodded after a minute, he awoke, and his Berger rhythm resumed. By this technique, his alpha waves were forced into a second rhythmic display. His ordinary rhythm—as long as he was alternately awakened and permitted to sleep—came at one-minute intervals. No clearer evidence could there be that the alpha waves depend, at least to a certain



A close-up of the motor-driven, continuous-film camera which photographs cathode-ray oscillographs

extent, upon moderate activity in the conscious brain.

Then, too, the alpha waves faint when a person swoons. Deep anesthesia likewise makes an end of the waves. Here it is of interest that where the anesthesia is light, the waves continue, but at a slower rate, perhaps only five or six per second, instead of about ten. Moreover, each anesthetic or drug seems to have its own peculiar effect on the waves, as shown by sharp-spiked or rounded waves, low or high waves (weak or strong), frequency high or low.

Oxygen also has an effect. Take many very deep breaths (with your eyes closed, to give your alpha waves a chance). With every deep breath, your alpha waves arrive more slowly. You could cut the beat in half—bring it down to five waves per second. The cause of this effect? Another mystery.

And so we see that, in the same person, the alpha rhythm differs from time to time, varying in accordance with numerous conditions. As one authority expresses it: "The alpha rhythm appears to be the labile indicator of something, but as yet we do not know what."

(*To be concluded*)

The Quest of Helen

At the Classical Site of Troy the Final Work of Archeological Excavation Has Now Been Completed ...Nine Superimposed Cities Revealed in New Detail

By JOTHAM JOHNSON, Ph.D.
University of Pittsburgh

Figure 1: A large room in a building in the sixth city level of ancient Troy. Its ceiling was supported by ten columns, arranged in two rows of five each

IT happened a long time ago if it happened at all, but to the ancient Greeks it was very real—one of the latest and freshest episodes in the age-long romance of their footloose, carousing, bronze-age ancestors. Three lovely goddesses took their beauty contest to a royal shepherd named Paris, and as objective decisions were improbable in those days, each goddess offered a persuader: Hera, unlimited power and dominion; Athena, fame and wisdom; Aphrodite, the most beautiful woman in the world.

Naturally, Aphrodite won. Paris presently found himself a guest at the Spartan palace of Menelaos, and violated the rules of hospitality which obtained then as now by seducing Helen and luring her off to his Trojan boudoir. In retaliation, Menelaos and his potent brother Agamemnon, king of Mycenae, led an army to Troy, and after ten years Ulysses' trick of the wooden horse put a squad of Achaeans within the walls and Troy was sacked and burned. Thus Mycenae's dangerous commercial rival at the mouth of the Hellespont was liquidated.

That is the story about which Homer wrote the Iliad and the Odyssey. We won't at this time go into the question of who wrote Homer's poems. One scholar has impatiently observed that if they were not written by Homer they must have been written by somebody else of the same name.

The Greeks accepted poet and poems as mostly true, while squabbling over details. In antiquity there were several solemn estimates of the date of the fall of Troy, based on the number of generations since—each prominent Greek family alleging descent from one or more of the Greek warriors who fought there. Eratosthenes worked out a date equivalent to 1184 B.C. Three other ancient chronologists accepted his figures and three independent calculations landed within a few years of that.

Few Trojans survived the sack. Aeneas escaped with Anchises his father and Ascanius his son. Later on the Romans were to consider him the founder of their nation, as Romulus, his many-times-great grandson, was to be the founder of Rome the City. They established a festival at the traditional site of Troy, though some writers, even in that day, argued that the site could not be reconciled with the Homeric tradition.

Vergil's Aeneid was a conscious borrowing from the Iliad and the Odyssey; Aeneas' flight via Sicily to Carthage, where he loved and left tragic queen Dido, resembles Ulysses' sea-wanderings till he reached his home, and the battle scenes in Latium, Aeneas' first adventures on the site of future Rome, suggest the fighting in the Iliad.

Later criticism was inclined to put the whole story down under the heading of entertainment. Sixty years ago, however, thanks to Heinrich Schliemann, the story was revived as almost-history. I am not going to waste your time or mine repeating his *American Magazine* success-story pattern—if you're interested you can look him up in an encyclopedia. From his boyhood he was a fervent admirer of the classics, reading and re-reading the Iliad. He could not persuade himself that Troy was not founded on fact.

WHEN he had made enough money, Schliemann retired from business and went to northwestern Asia Minor to find Troy and dig it. Several explorers before him had noticed that the smallish mound of Hissarlik fitted roughly the topographical requirements of the siege described in the Iliad, and it had satisfied the Romans. Schliemann excavated a mammoth trench right through its bowels, for which archeologists have been cursing him ever since.

He unquestionably landed in something. He distinguished seven successive strata, levels of occupation. The seventh city he called Greco-Roman, the sixth "Lydian", the rest prehistoric. I have already explained in this magazine (May, 1937, page 310) that "prehistoric" means before the use of written documents, which constitute history; and that prehistoric archeology, which is the harder of the two, is currently more fashionable among archeologists than the other kind.

Down near virgin earth Schliemann found a primitive city, surrounded by strong fortification walls, and evidently wealthy. Furthermore, it had been destroyed by fire. He announced to a frankly skeptical public that he had proved Hissarlik Level III to be the Troy of Homer. One of his staff observed that the burned city was only one remove from bedrock, and was therefore Hissarlik II, and in a later volume Schliemann made the correction. Troy I, a cluster of wretched hovels at the very

bottom, he considered neolithic. He gratefully removed a rich Troy II treasure of copper, silver, and gold cups and jewelry from Turkish jurisdiction, which cost him his permit to dig.

Accordingly, he moved to Greece and pitched his tent at Mycenae. At once he found the royal "circle graves," which have been a sensation ever since, and the palace in which Agamemnon may have—must have—lived. Anybody who is that lucky is bound to rise. Schliemann's digs at Ithaca, Orchomenos, and Tiryns were less successful, but in due course he rose in public estimation from a crackpot to something of a savant, and died believing that in Troy II he had laid bare the Troy of legend.

IN the meantime the school of Aegean archeology which he fathered had been reclassifying and recomparing the primitive potteries from Troy and Mycenae and elsewhere in the lands bordering the Aegean Sea, and began to articulate their suspicions that Troy II was far older than the palace of Mycenae. Mycenae's chieftains came at the very end of the bronze age, and soon after 1100 B.C. were overwhelmed by invading "Dorian" Greeks who brought with them the first iron and therefore can usually be recognized even by very young archeologists. Troy II, on the other hand, was very early bronze-age, and being rapidly pushed back toward 3000 B.C.

Schliemann died in 1890. In 1893, with funds contributed by Mrs. Schliemann, and in 1894, at the expense of the German government, Wilhelm Dörpfeld, a capable young German architect who had been associated with Schliemann, returned to Hissarlik for further exploration. He counted nine cities on the mound instead of seven and paid special attention to the upper levels, especially the sixth which Schliemann had called "Lydian." He found what Schliemann had overlooked—the walls of a fortress enclosing Troy VI, a city larger and much more powerful than Troy II, and likewise destroyed in some fearful catastrophe.

The pottery associated with it, by which it had to be dated if it was going to be dated at all, was not Lydian but *was* directly comparable with late bronze-age pottery from Greece, some of it perhaps made at Mycenae itself. Dörpfeld accordingly gave out that Schliemann's Troy VI was prehistoric, contemporary with Agamemnon's Mycenae, and could be shown to fit the Homeric requirements so beautifully that no dispute could ever arise again.

He carried conviction, too; the Troy II advocates were about ready to change over, the hold-outs who had been objecting to Troy II as too early were delighted, and most of the uncritical followed along. There remained only a small but shrill French school of dissidents who had plumped for an opposition mound somewhere farther back in the hills. In due course the history books, or most of them, were rewritten to acknowledge in Troy VI the rebirth of the Homeric city.

Figure 2: A gate and street of Troy VI. After the earthquake that destroyed the sixth city this gate was repaired and used again in Troy VII*a*, Homer's Troy

It was inevitable that someone would question again the patient soil of Troy. Sir Arthur Evans' exploration, from 1900 on, of the Palace of Minos at Cnossos in Crete, revealed that a brilliant bronze-age culture centered there had dominated the Aegean area for centuries. Synchronisms with Egypt provided a fairly accurate scale of dating for the whole span of Minoan culture. The British excavations of Phylakopi

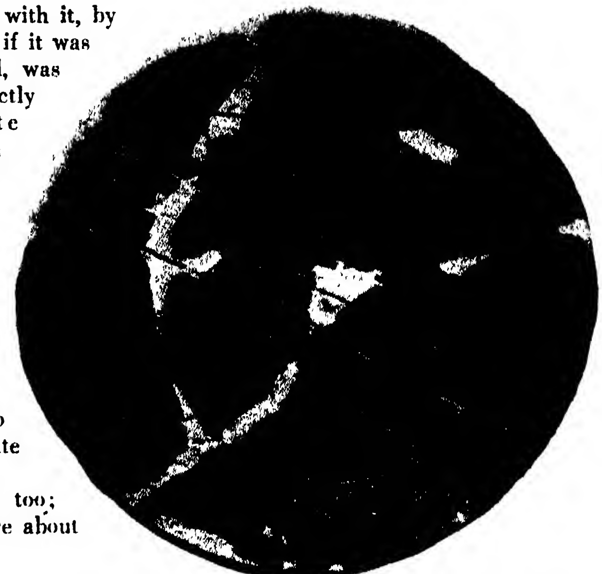


Figure 3: The lid of a box, found in a destroyed house belonging to Troy IV*a*. Despite the small swastika shown toward its left, the "horizon" is clearly non-Aryan

on Melos had furnished a similar scale for the island culture, and the mainland chronology had been steadily improved—by Wace's re-excavation of Mycenae in 1921-3, the German reëxcavation of Tiryns, American excavations at Korakou and Zygouries near Corinth and at Eutresis in Boeotia, and British exploration of numerous sites in northern Greece. Yet we were still without an accurate yardstick for the coast of Asia Minor, for Schliemann and Dörpfeld between them had raised as many questions as they had solved at Troy, and the Turks, having newly fortified their coastal zone, were at no pains to encourage foreign enterprise among its buried mounds.

However, they would permit further work at Hissarlik, where, with all the fortune that had been poured into moving it, extensive strata of the original mound still lay undisturbed; and no other site in western Asia had the romantic associations of Troy. The University of Cincinnati, a strong newcomer to the field, qualified for the honor and each spring for seven years Carl Blegen, Professor of Archeology at the University, has returned to dig at Hissarlik.

Results during 1932 were nothing much—limited to new details of the fortification walls of Troys II and VI. In

1933 primitive Troy I, which Schliemann had treated with considerable disdain, was put to an especially thorough examination to learn its true ancestral nature and to see whether beneath it there might lie a city still older. There was none, but the improving classification of pottery and other finds made it necessary to divide level I itself into four periods, *a*, *b*, *c*, and *d*, and later it became necessary to subdivide period I*a* into four sub-periods, I*a*1, I*a*2, I*a*3 and I*a*4.

In that same campaign Troy V was divided into periods *a*, *b*, *c*, *d*, and *e*—I hope I'm not boring you—and Troy by alien forces; if Troy VI was Homer's Troy then its beaten, scattered survivors had returned with surprising vigor to mend their broken lives and rebuild their city.

1934 was the year of the big wind. After that campaign Blegen announced that the catastrophe which had destroyed Troy VI shortly after 1300 B.C. could not have been the conqueror's torch, for it was impossible to recognize over the whole site a general layer of ash and carbonized matter which would indicate such a conflagration. Instead, its fortifications and house walls had been shattered by an earthquake.

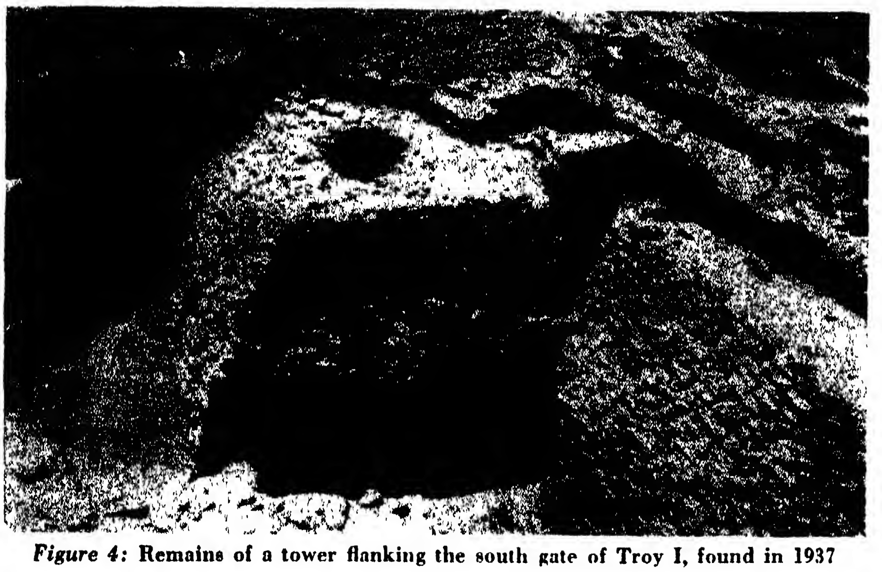


Figure 4: Remains of a tower flanking the south gate of Troy I, found in 1937

VI yielded new quantities of "certified" pottery; that is, lying in undisturbed stratification. Troy VI was architecturally ambitious; one of its imposing buildings is shown in Figure 1—a spacious hall whose roof was supported first by four, later by ten columns, anticipating the plan of the Roman basilica whose name the excavators have temporarily borrowed for it. This city had a long period of steady cultural development reaching from before 1900 B.C. to after 1400 B.C., and it is likely that it was one of the most important commercial cities in the world during that period.

ALSO, in 1933, it was ascertained that Troy VII, the sub-Mycenean settlement built on the ruins of the sixth city (in Dörpfeld's renumbering of Schliemann's strata) had three periods, VII*a* being still bronze-age, iron making its first appearance at Hissarlik in Troy VII*b*. VII*a* showed ominous signs of destruction.

It had been growing more and more difficult to show any cultural break between Troy VI and VII*a*. It was true that there was a destruction level separating them, but the culture, as indicated by the finds, was continuous, indicating that the same people had gone on living there after the tragedy, not supplanted

On its shaken foundations the city had been reconstructed. In some places the fortification walls had to be torn down and rebuilt; in others they were relatively solid and so were returned to use. Figure 2 shows a good example, a gateway which belongs to both Troy VI and VII*a*.

Troy VII*a* was a century old when, soon after 1200 B.C. according to the archeological evidence, it was gutted from one end to the other by fire. It alone, of all the levels of Hissarlik, satisfies the requirements of Homer's Troy. And that is the date indicated by the consensus of the Greek genealogists who worked out dates for the Sack of Troy.

Above the ruins of Homer's Troy was built Troy VII*b*, a mixture of Trojan, sub-Mycenean, and new alien elements —indeed a poor village, but knowing iron. Back before 2000 B.C., Troy III and IV turned out to have been not separate cultures but one city, a sequence in a slowly-developing bronze-age civilization, interrupted, it is true, by a fire, but one not attributed to hostile invasion. From the earliest of Troy IV's five periods comes the cover of an ointment-box, reproduced in Figure 3.

In 1935 and 1936 Troy II was scrutinized again, and divided into periods *a*, *b*, and *c*, and *c* in turn into 1, 2, 3, and 4. Troy II had fairly pretentious buildings, more so than the early excavators realized, and Blegen's discovery in this second city of gold objects duplicating examples in Schliemann's treasure confirms Schliemann's identification of the level in which his treasure was found.

This sort of thing, with ancient wells to open, Greek and Roman buildings and inscriptions to record, cemeteries to search for, is what keeps the archeologist lean but happy. When all the subperiods of all the periods of Troy's nine cities are totaled they now—July, 1938 —number more than 40, subject to change without notice.

It remained for 1937 to bring Troy I into true focus. Through all the older excavations and five modern campaigns, even the intensive researches of 1933 and 1936, it had kept its secret, its small but powerful fortification wall built of stone, its great south gate flanked by projecting towers (Figure 4). Instead of a sub-neolithic village it stood revealed as a stout guardian of the Dardanelles, a customs house set to badger Black Sea commerce 'way back in a day so close to the dawn of navigation that

Figure 5: Oldest known sculpture from the Aegean area, found outside the south gate of Troy I. It represents a heart-shaped human face

we are at a loss to imagine what commerce was worth regulating.

Built into a barrier outside one of its gates stood three stone slabs, re-used from some monument still older, and on one of them was a rude representation of a human face (Figure 5), the oldest piece of monumental stone-carving in the Aegean area and one of the oldest in the world.

The excavation is now complete. Last spring the staff from the University of Cincinnati returned to Troy for a final season of study, and presently the re-publication of the site will begin.

Floods Give Fair Warning

Lives and Property Can Be Saved if the Warning is Heeded . . . Flood Patrol Co-operates With Amateur Radio . . . The Gulf Stream of the Air

By ALEXANDER MAXWELL

EARTHQUAKES and tornados strike quickly and unexpectedly. Hurricanes give several days notice, while a flood may be a week or more building up to the point where it becomes destructive. Yet more damage is done by flood waters than all other natural disasters put together. Half of it, or more, is preventable.

In the May issue of Scientific American, page 261, is told the story of the mighty TVA and the almost superhuman task of remaking an entire river basin for the purpose of minimizing flood losses, making year 'round navigation possible, providing mosquito control, and impounding water for power purposes. One feature of this project is the forecasting of floods in the Tennessee River and its tributaries. It is a complex procedure; by adjusting the control gates on a series of dams, a flood crest can be ironed out so that no one point gets all the raging torrent at once. This complex system saved Cairo in the flood of January 1937. It saved it by inches. By closing the gates in the face of a cloudburst, an additional crest of six inches was delayed; the hard-pressed levee was not topped. If the TVA never does another good deed, that one demonstration will stand as a monument to man's triumph over flood waters.

FLOOD damage in the Ohio Valley has made a deep impression. Giant dams cannot be used as on the Tennessee River. No other method of flood control seemed practical. Many were suggested, but when figures showed that a storage basin the size of Lake Erie would not hold the flood waters of the Ohio when on a rampage, those who had suffered looked up in despair and said: "What can we do?"

A number of newspapers serving the Valley provided the answer. They saw what had happened and pooled their resources to inaugurate a project unique in dealing with floods. Contrary to most projects which require millions or billions of dollars, this one depends mainly upon the human element. Men, skilfully directed and all working together, can accomplish much, even with meager financing. The project looked almost pathetic, but when tested in the spring of 1938 it proved an unqualified success.

To begin with, what causes a flood? We all know about the ocean current called the Gulf Stream and how it circulates in the Atlantic Ocean. What we were not taught in school was the presence of another Gulf Stream, not in the ocean, but in the air! Meteorologists have long suspected its presence, but only recently, when world-wide weather reports could be assembled with speed and accuracy, has its existence been checked and verified. Visualizing the Northern Hemisphere as a whole, the path of this mysterious river of the air is unmistakably clear. It flows in a well defined channel, but like all rivers, it has the power to alter its path to meet changing conditions. Coming from the tropics, it is heavy with moisture. As it flows along, its path is marked by clouds—the fleecy, billowing type which artists so admire, or again, by the villainous thunderhead, just waiting to ruin a picnic. If you could ascend high enough, the path of the Gulf Stream of the Air would be visible as a great, meandering streak of clouds. A meteorologist compiling his daily chart gets just such a picture on the map before him.

Damage by floods can be materially reduced if adequate warning is received and proper precautions are taken to protect property

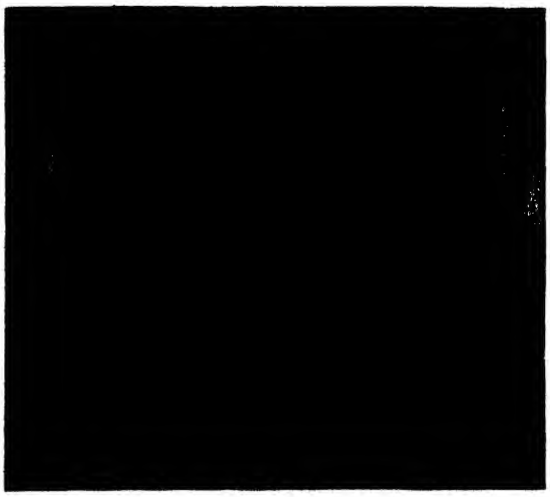
This Gulf Stream of the Air is much more important to our welfare than has been generally supposed. On the whole it is quite agreeable, but every so often it turns with a snarl of wind and thunder; rainfall which should have been distributed evenly over most of North America is concentrated in a restricted area, resulting in a cloudburst, or, if heavy enough, in a flood. When there is a flood there is also a drought—in a place which should have received its share of the rain but did not.

The Gulf Stream of the Air never follows the same course for very long. It snakes and twists like a giant fire hose. One day it will be over the Atlantic Coast; then it heads west until it brushes the towering heights of the Rockies. Later it slithers into the Mississippi Valley and eventually back to the East. Wherever the current goes, there are found rain storms. When the Gulf Stream of the Air is elsewhere, the skies are clear and there is no rain. In short, it is the generator of floods.

Floods do not start in the river channels. The drainage area of the river proper is not sufficient to build up floods. However, should the headwaters of a number of tributaries receive heavy precipitation simultaneously, the hillsides will drain into brooks, the brooks flow into runs, the runs into creeks, the creeks into small rivers, the small rivers into larger rivers, and when all the tributaries pour their muddy torrent into the main river at the same time—the flood is here.

SEVERAL days usually elapse between the time when the Gulf Stream of the Air discharges its liquid burden and the river rises. By watching atmospheric conditions the forecaster can tell when and where to expect heavy rains and be prepared for them. The elaborate system of the TVA does this, and never yet has high water come unexpectedly. The Ohio Valley newspapers are applying the forecasting in a different manner.

Water travels slowly. Last year, when a big Ohio flood was anticipated, an expedition went to the headwaters of the rivers rising in the Virginia-Kentucky-Tennessee triangle to watch developments and take photographs. Rainfall did not seem unusually severe, but shortly



Portable short-wave radio equipment used by the flood patrol to report rising water conditions to areas which will soon be affected

after New Year's Day the creeks began topping their banks. They had already gone down to normal long before the first warning of a flood was sounded at Louisville. The water traveled down each stream in a miniature "tidal wave." It rose rapidly, stayed at crest a certain length of time and then fell just as quickly as it had come up. It was possible to follow the progress of the flood by automobile, taking photographs before, during, and after the crest hit a given spot. Then, by driving rapidly a hundred miles down stream, the whole performance could be seen over again on a larger scale, until at last Cincinnati was reached, where the water soon began to lick the doorsteps of houses.

Ninety percent of those who lost life and portable property in last year's Ohio flood did so needlessly. There was a full week in which to prepare—had coördinated information been available. But there were no clearing houses for flood reports.

PREVENTING floods in the Ohio River is still far in the future. It may never be entirely successful. On the other hand, getting out of the way of a flood is something which can be done right now. That is exactly where the newspapers decided to help. The weak link in the chain was the absence of reliable advance information on the movements of flood waters. The water was coming—but, how much? How fast? When will it get here? Which homes should be evacuated? How high should sand bags be piled? Every city along the river has ample facilities for handling its inhabitants and their belongings, if ample and accurate warning is available. To provide such warnings the newspapers have established their own advance information bureau. This "flood patrol" at first glance appears to be a cross between the pony express and Paul Revere. Not having money to establish measuring stations at the headwaters and at strategic junctions of streams, a survey party laid out routes along surfaced highways, connecting the tributaries of the rivers which fed the Ohio. Speeding rapidly by auto from stream to stream a single observer can measure the level and flow of many isolated watercourses in a short time.

The system of patrol routes does not hug the river; it reaches far into the hinterlands. Parts of the states of Ohio, Indiana, Illinois, Pennsylvania, Maryland, New York, West Virginia, Virginia, Tennessee, and Kentucky are included. Observation posts within 50 miles of the Ohio are worthless. It seems odd to think of looking for floods on a mountain top, but that is where the trouble starts. The patrol functions only during flood season. If the observations of the meteorologists show no trouble in the offing, four men can patrol the entire Ohio Valley, making the circuit twice a week. Should the position of the Gulf Stream of the Air indicate undue rainfall, the patrol can be increased, sending daily or even hourly reports by telephone, telegraph, or short-wave radio to the central clearing house. With all the water levels of the numerous tributaries clocked and measured, it becomes a simple matter to calculate the quantity of water which will pour into the Ohio at any time within the next week.

That such information will be valuable is proved by the experience of the inhabitants of Portsmouth, Ohio, during the flood of 1937. Portsmouth, a low-lying city, had been flooded before. The people knew better than to argue with the river. Acting upon such meager information as was available, coupled with hard-earned experience with past rampages of the river, Portsmouth was completely evacuated. Stock was moved from stores, plate-glass windows were boarded over, homes were deserted, all before the river arrived.

But this case was the exception. In other cities on higher ground there was a mad last-minute scramble to escape through water that was already knee deep and rapidly rising.

A major flood is usually accompanied by numerous minor accidents such as washouts and breakdowns where communication is interrupted. Short-wave radio can bridge that gap, or, in fact, any gap. There has been no disaster, major or minor, during the past 12 years, from war to explosion, from earthquake to flood, anywhere in the civilized world, where short-wave radio has not stepped in and filled the breach in shattered communications systems.

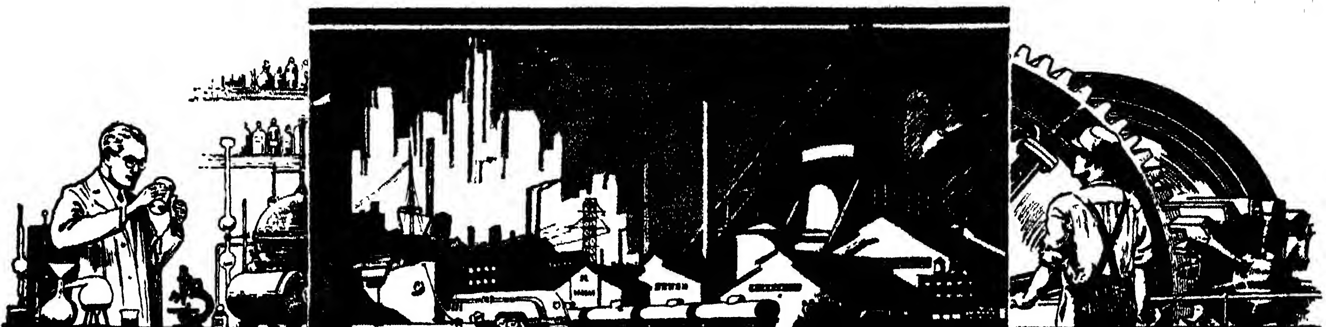
That is a record to cherish, and more so because almost all of those who participated did so voluntarily. Amateur radio. The American Radio Relay League. Men who follow radio as a hobby. Thousands of amateur listeners are continually combing the air waves. Hardly a thing escapes them. Many a message of distress which was not heard by government or commercial operators, paid to listen, has been picked up by amateurs and relayed to the proper authorities, usually at the expense of the amateur. A large number of amateurs risked pneumonia and braved severe hardships during the last Ohio flood, handling messages, directing relief and ordering supplies—voluntarily, using their own equipment and being paid by nobody. They have been on hand whenever needed, so it is not strange that the flood patrol includes them in the program. They would be there anyway.

To test the system of flood reporting by radio under field conditions, one of the patrol cars took an RCA 40-watt phone and C. W. transmitter up into the wilds of the Cumberland Mountains. With power furnished by a half horsepower gasoline engine, no trouble was encountered in putting signals into civilization. Such a radio unit, transported on the back seat of a car, can be set up in a house, barn, or tent, and be on the air in ten minutes. A 40-foot gas pipe is all the antenna needed, and a length of chicken wire serves as a ground. Lower power sets mounted permanently in cars can communicate while on the run, though their range is not as great. So far there has been no need for such split-second communication.

The antenna pipe screws together and rests on a porcelain insulator. One man can push it up and hold it while another drives the stakes on the ends of the three guy wires. Dismantled, it is lashed to the running board while the ground is rolled up and placed behind the spare tire. All equipment is standard and of the type used by many amateurs.

THE flood patrol functioned for the first time in the spring of 1938. No floods threatened, but it was inaugurated as an experiment to prove the feasibility of the plan, and see just how rapidly all the desired information could be assembled when an emergency did arise. Now, when a flood threatens, each of the coöperating newspapers can keep its readers informed, and when a notice to move is given it will be issued with assurance. No longer need the population of a threatened area rely upon pure guesswork; there will be no false alarms to upset those already on the verge of panic.

Huge sums do not need to be spent to accomplish things worth while if men are willing. The Ohio Valley flood patrol is ready; it is there to give exact information to those needing it most, but it is hoped the emergency will be a long time coming.



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER

Chemical Engineer

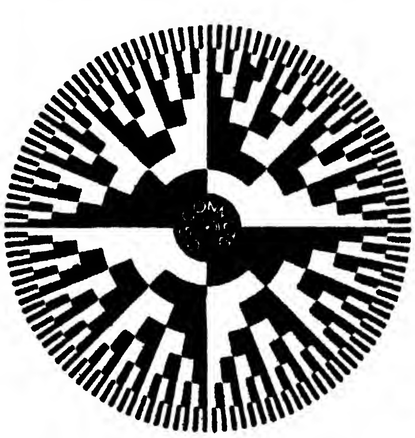
Instrument Measures Musical Frequencies

A NEW device called the Conn Chromatic Stroboscope has been developed for the precise and rapid measurement of sound frequencies in the range represented by the piano keyboard. By an entirely visual method, the deviation of a given tone from the equally tempered scale based on the standard A of 440 cycles per second, may be read directly, without further computation or reduction. The instrument may be used in the testing of musical performance; in making measurements of intonation, both vocal and instrumental; in piano and organ tuning; and in musical instruction and demonstration.

Testing intonation of a clarinet

Two units and a microphone comprise the complete stroboscope outfit. One unit, called the "stroboscope unit," has 12 windows having the relative positions of the white and black keys of the piano keyboard. The 12 notes of a chromatic octave starting with C are thus represented. Behind each window is a rotating disk imprinted with a pattern consisting of seven rings of alternating light and dark segments. Each ring, progressing radially, has twice as many segments as the preceding one. These disks are illuminated from behind by a gaseous discharge tube which is made to flash in accordance with the pulsations of sound reaching the microphone. When the number of light pulses per second is the same as the number of dark segments passing per second on some ring of one of the disks, that disk will appear to stand still. When the same note is sounded an octave higher, a similar pattern appears in the same window with twice the number of bars, since the frequency is doubled. The position of the pattern is also shifted to the next ring of the figure. Space is provided for seven octaves on each disk and, with the 12 windows, a total of 84 notes may be checked.

When the pattern remains stationary the tone sounded is correct in intonation. However, if the tone is sharp, the pattern will move toward the right. If flat, the pattern will move toward the left. To find out just how sharp or flat the tone is, the operator simply turns a knob on the "fork unit" to the right or left (in the same direction as the motion of the pattern) until the pattern appears stationary. The reading on the dial gives the exact degree of deviation from the correct tuning expressed in hundredths of a semitone (cents).



One of the stroboscope disks used in measuring musical frequencies

While the stroboscope was developed primarily for testing the intonation of most wind instruments, it has been found adaptable to a wide variety of uses where accurate measure of frequency is involved. For example, piano manufacturers and tuners saw in it an accurate device for measuring the tuning of the piano. Teachers of music, bandmasters, and orchestra directors see in the Chromatic Stroboscope a means of ear training. Limited experience with the stroboscope in this connection has revealed some remarkable progress by students who formerly played with faulty intonation.

Bonnet Protects Giant Bearing

THE world's largest telescope bearing practically crawled to a new world's marathon record recently, wearing a sunbonnet and chalking up a seven-mile-long grind in 131 working days. Literally, it was a hard grind too, because the 317,000-pound horseshoe-shaped bearing lost approximately one and a half tons of steel in the undertaking.

This race for perfection—and not speed—was run on a 144-foot track in the generator works of the Westinghouse Electric & Manufacturing Company. A specially constructed

Courtesy Pittsburgh Plate Glass Company

A bullet shot from a Springfield army rifle at a distance of 60 feet penetrated the ⅝-inch-thick boiler plate shown in the foreground. Under the same test conditions a bullet penetrated only ½ inch into the plate of laminated safety glass shown behind the boiler plate

boring mill machined, ground, and polished the bearing to within five thousandths of an inch of a perfect circle.

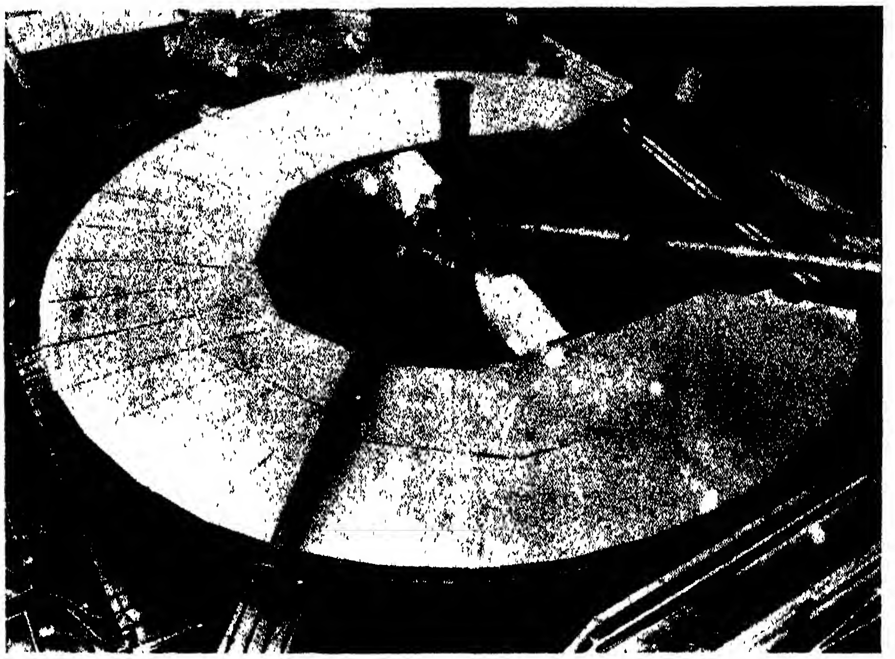
Hard but sensitive is this titan of steel, and that accounts for the sun-bonnet. Westinghouse research engineers prescribed the bonnet, a composition roof, to reduce the expansion effect of the sun's rays on the steel. The bearing had to be smoothed to perfection in order to carry the million-pound weight of the 200-inch telescope which will be erected atop Mt. Palomar, California. The few thousandths of an inch expansion caused by the sun's rays streaming through the skylight in the generator aisle became a mountainous problem for the engineers.

Shortly after starting the machining process they discovered that every afternoon around 4 o'clock, the telescope bearing began to swell as it revolved slowly on the circular track of the boring mill. While the temperature increased approximately 10 degrees during the late afternoon sun bath, the steel expanded as much as 13 thousandths of an inch. At night it contracted.

Checking surface of giant bearing

What's more, the stubborn bearing did not expand evenly. At the bottom of the horseshoe, farthest from the sun's rays, the expansion was only seven thousandths of an inch. For two weeks an engineer filled reams of paper with calculations until he had charted the complete course of the expansion for every revolution of the bearing and was able to adjust the grinding wheels in the proper ratio.

Expansion continued to be a handicap, however, and the engineers next covered the skylight of the plant with blue paint. This reduced the expansion some. Next they built the bonnet a few inches above the revolving bearing. Immediately they reported a 50 percent reduction in temperature fluctuation and a corresponding cut in the expansion.



Looking down on the sun-bonnet that protects the huge telescope bearing

With the sun out of the way, craftsmen worked the huge bulk of steel into a perfect circle with a face almost as smooth as glass and bright as nickel. They didn't trust their eyes to tell them when they had attained smoothness, but Dr. Stewart Way, a research engineer, spent many hours exploring the surface through a surface finish microscope, plotting a profile map of the bearing. Through the microscope, ridges a few thousandths of an inch deep appeared like craters.

Relentlessly the polishing wheels buzzed and the microscopic hills and valleys on the steel surface grew smaller, to less than five ten-thousandths of an inch in depth. Engineers had won the battle with sun and steel.

Rubber Bands Snap at High Speed

Two hundred and four miles an hour is the speed at which a stretched rubber band snaps, as measured by ultra-high-speed motion pictures recently taken in the laboratory of Gustavus J. Esselen, Inc., chemical consultants.

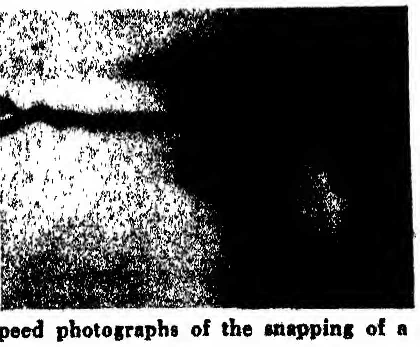
"An ordinary rubber band, about four inches long, was stretched nearly to its limit with the fingers, and as it was released photographs were taken of it at intervals of a twelve-hundredth of a second," Dr. Esselen explained. "When these pictures were studied, the mechanism of the recoil of the rubber could be easily observed and measured. The free end of the band relaxed first and gradually more and more of the band lost its tension, the end held in the fingers last of all. During the snapping, the free end of the band attained a measured speed of 204 miles per hour.

"This technique of taking ultra-high-speed motion pictures has been used with great success in solving industrial problems involving motion too fast to be followed by the eye alone," Dr. Esselen said. "In effect, action can be slowed down as much as 125 times. An object moving at a rate of 125 miles an hour, or 183 feet per second, which is much too fast for the eye to see, can be photographed and shown traveling at a rate of only one mile an hour, or about one and one half feet per second. At this speed it is easily watched and the nature of the motion analyzed in detail. In measuring the speed of the snapping rubber band, motion was slowed down only 75 times."—*D. H. K.*

Hogs Lose a Job

"Exton," a new bristling filament for use in toilet brushes, has just been announced by the Plastics Department of E. I. du Pont de Nemours & Company as the result of several years of research and experimentation. The present production is limited and the entire output is being used in du Pont's own tooth brush manufacture.

The new bristling filament is ultimately expected to replace the natural hog bristle which has heretofore been used in the best grades of toilet brushes. Made from a plastic dough-like batch, it is extruded through holes of the required size and can be made



Three high-speed photographs of the snapping of a rubber band

into strands of virtually any desired length. It is not softened by water or saliva. Its stiffness can be controlled accurately in the making through variation of the diameter of the hole.

Experiments have shown that the new synthetic product is superior in appearance and has much longer life than the natural bristle.

A Thrill for the World's Fair

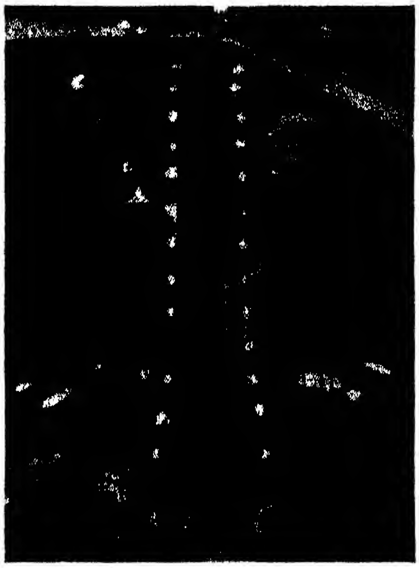
WE have had occasion to describe in these columns the system of training in parachute jumping with the aid of "Parachute Towers." Now we are privileged to describe the parachuting tower which will

be erected by International Parachuting at the World's Fair. The hazards of the jumps have of course been reduced to a minimum, and there will be no such thing as instructing the public to pull the rip cord, or even an attempt to have automatic opening of the 'chute. On the contrary, the 32-foot 'chutes will be held permanently open by big metal spreaders. The passengers will be held securely and comfortably fastened in a double seat suspended from the 'chute. An automatic release will start the drop and the 'chute will be guided by vertical wires to prevent swaying during the descent. Shock absorbers will eliminate any effect of impact on alighting. Then the 'chute will be hauled back to the top of the tower.

Eleven of these devices will be in constant operation. Both ascent and descent will take about one and a half minutes each. Even though the World's Fair jumpers will not experience the thrills of a man bailing out of a ship, they will enjoy quite a novel experience, and a splendid view of the fair from a height of 250 feet. The whole structure will weigh 170 tons, but is so constructed that it can be readily dismantled and assembled elsewhere. Perhaps the parachute tower will in time become a familiar feature of the really modern traveling circus.—*A. K.*

An Aerodynamic Novelty

AS one of our photographs indicates, The Willoughby Delta Company of London, England, has produced an entirely



Above: An artist's drawing of the parachute tower as it will appear at the World's Fair. *Left:* One of the parachutes at the end of its descent, showing size in comparison with the couple in the seat

new and interesting aerodynamic form in their "Delta" wing. The Delta airfoil includes a normal wing of moderate aspect ratio, and two "side wings" which are cambered sideways as well as fore-and-aft. In combination with the tail surfaces there is formed an "annular wing" of rectilinear formation.

Much original thought and careful wind tunnel investigation have gone into the development of this twin-engined Menasco-powered Delta type airplane now approaching completion. Some of the striking results claimed by the designer, P. Nesbit Willoughby, are:

1—The side wings act as booms to carry the tail surfaces, but provide lift (at all but the smallest angle of incidence) so that they are *not* purely parasitic elements as ordinary tail booms would be.

2—In a very large machine the thick booms of long chord permit complete housing of passenger cabins on either side without the addition of parasite drag, while the central nacelle can be given a relatively small frontal area and small drag.

3—In the ordinary wing there are "vortex" losses at the tips and all along the trailing edge. In the Delta there is an annular lifting line closed on itself so that "vortex" losses are reduced. This explains the high lift/drag ratios attained with a relatively small aspect ratio.

4—The aircraft maintains its lift well beyond the stall of the conventional airfoil, because after the front wing has reached its maximum lifting capacity, the side wings still continue to increase in lift. This means that sudden stall or loss of lift will be avoided.

5—As raising or depressing the elevator affects the whole aircraft, the longitudinal control is very powerful in spite of the small size of the elevator.

6—With the conventional airplane of large size the bending moments at the root of the wing become very large and the structural weight goes up accordingly. With the Delta design, weight and lift distribution are more nearly coördinated; this tends to increase strength and decrease structural weight.

Of course the above is a highly condensed statement of reasoning which would require a lengthy, technical paper for adequate presentation. Also, technicians may find arguments *contra* as well as *pro*. Nevertheless, it is quite clear that serious consideration must be given to these novel principles; the disclosure of wind-tunnel tests and the results of flight tests will be awaited with interest in Europe and the United States.—*A. K.*

PLANE TIRES

THE largest tires so far used in American aviation—those built for the new DC-4, 42-passenger air-liner under construction by Douglas Aircraft Company—contain 45 miles of tire cord and four miles of bead wire each, and weigh 360 pounds.

Engines for Various Types of Aircraft

THE United States took an early lead in the development of the air-cooled engine, with Charles L. Lawrance as the outstanding pioneer, and it has kept this lead ever since. The progress in air-cooled engines has been truly remarkable, and their power for a given weight and over-all diameter is now surprisingly high. However remarkable the success of this type may be, some authorities are of the opinion that we have been remiss in the development of other categories of aircraft motors. The Germans, so these authorities tell us, have taken a broader view, and while making the fullest use of the air-cooled type have also pushed ahead with liquid-cooled gasoline engines, and with aircraft Diesels.

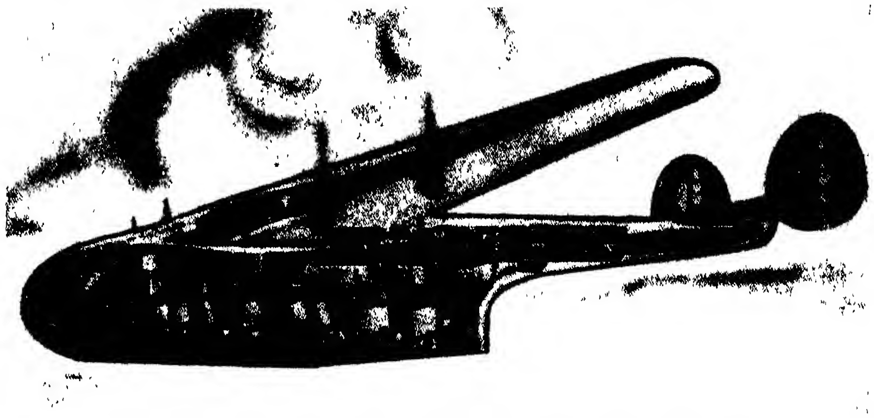
Broadly speaking, the Germans have classified their prime movers under the following headings:

1—Liquid or chemically cooled engines of small frontal area, fitting admirably into the nose of a fuselage and allowing the designer to build single- or two-seater fighters of the highest speed.

A model plane built with the Delta annular wing

2—Large air-cooled gasoline engines for machines of intermediate size—observation, light bombers, and so on.
3—Powerful Diesels with low fuel consumption for very large airplanes with long range endurance, in which the weight of fuel is a highly important item.

Of course we now have the Allison engine to represent the liquid-cooled category, but we have no large aircraft Diesels in service. We might do well to follow the German example, and without being carried away by the success of one category, seek a more comprehensive coverage of the aircraft engine field.—*A. K.*



A portent of the future—passengers housed within the wing

Sleeve Valves for Aircraft Engines

IN 1905, Charles Y. Knight of Chicago began his work on the subsequently famous double-sleeve-valve engine, and there is no doubt that the honor of originating the sleeve-valve internal-combustion engine rests with the United States. Yet it is the Bristol Company of England that has done the most creditable work in developing the sleeve valve for use in the aircraft engine. Now that an intense effort is being made to develop two-cycle Diesel engines for aircraft use, the sleeve valve is sure to come into its own, and we predict confidently that American engineers will no longer neglect this device. Space considerations will not allow us to discuss the sleeve valve and its possibilities in full, but the following résumé of the advantages claimed for it in A. H. R. Fedden's recent paper presented before the Society of Automotive Engineers is of real interest:

There is a total absence of valve maintenance and of any hot spot in the combustion chamber. Since pre-ignition and detonation are often traceable to the red-hot exhaust poppet valve, this latter item appears quite important. There are greater effective valve areas and reduction of restrictions to the gas flow. The poppet valve, however skilfully designed, and even if four valves are placed in the head, suffers from definite limitations as to valve area. In the sleeve valve, almost the whole wall of the cylinder may be used for gas inlet or exhaust. Large valve area is particularly valuable in achieving rapid scavenging in the two-cycle engine. Sleeve-valve engines are relatively silent in operation.

It is possible to achieve any desired control of cylinder turbulence in sleeve-valve engines. Fuel injection is one of the secrets of the aircraft Diesel, and successful injection must be accompanied by proper swirl and stratification of the incoming air. The sleeve valve gives the designer a chance to secure these ends.

In all probability the best combustion chamber should have a perfect hemispherical shape. It is clear that this cannot be achieved with a poppet valve system, but is perfectly possible with the sleeve valve. It is further claimed that there is a decrease in the number of parts.

Perhaps Mr. Fedden has glossed over some of the difficulties, such as cooling through a double wall; namely, valve sleeve and cylinder proper. Also, actuating the sleeve valve through cams from the crankshaft is a nice mechanical problem. Probably an experienced poppet-valve man would have other "contrary" arguments to offer. Nevertheless, we will go along with Mr. Fedden in saying that the sleeve valve deserves full study on the part of American designers.—*A. K.*

Design Trends in Giant Flying Boats

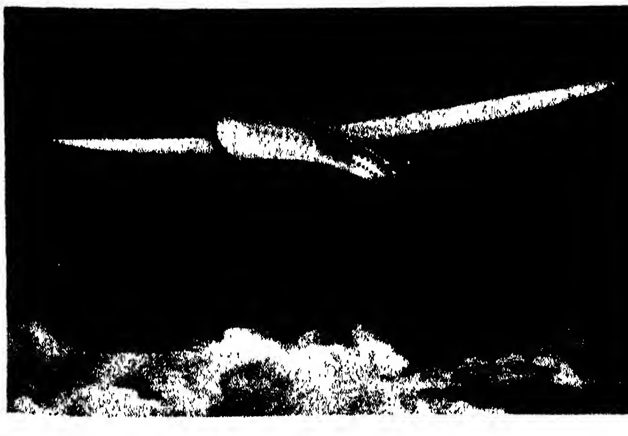
WHILE American, English, French, and German airlines are making their transatlantic survey flights with existing equipment, it is interesting to consider what transatlantic flying boats may be like in a very few years. According to a paper by I. M. Laddon and T. P. Faulkner in the *Consolidator*, even the latest Boeing Clipper is but a forerunner of greater things to come. These authors predict:

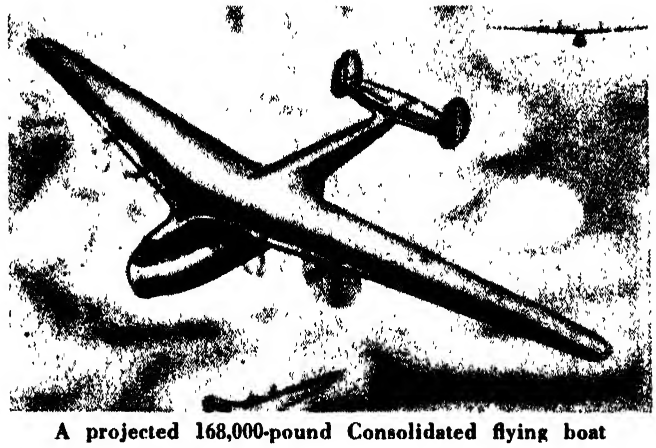
1—Increase in size to a gross weight of 400,000 pounds and more. 2—Three hundred passengers, with baggage, mail, and express, and a range sufficient to cross any ocean non-stop. 3—Speeds of over 300 miles an hour in the stratosphere. 4—Comfort and equipment fully equal to that of an ocean liner. 5—A means of "assisted take-off" (such as a catapult) so that schedules will not be affected by water conditions. 6—Increase in size of wings, allowing all passengers and operators to be accommodated within the wing; thus the hull will assume much smaller proportions and project far less below the wing. 7—Higher wing loadings and the use of stainless steel instead of aluminum alloys, particularly in places of great stress concentration. 8—Large, dependable, liquid-cooled engines completely housed. At the beginning of a voyage, all six engines might be brought into play, and then as fuel load is lightened, two engines might be taken out of commission with "hydromatic feathering" propellers set edgewise into the air stream.

Announcements of the bids recently submitted to Pan American Airways substantiate these trends. Five important companies—Boeing, Consolidated, Douglas, Seversky, and Sikorsky—have submitted designs which are being examined by a Technical Committee of which Colonel Lindbergh is a member.

The design presented by Consolidated Aircraft is to weigh 168,000 pounds and develop a minimum average cruising speed of 240 miles an hour for a 5000-mile range. Four liquid-cooled engines of 2150 horsepower each are to be located between spars in the wing, with an extension shaft driving the tractor propellers. Access to these engines will be available during flight for servicing and minor repairs. Auxiliary tip floats disappear into the wing in flight. It is proposed to house 36 passengers in the

Sikorsky's conception of the future Super Clipper





A projected 168,000-pound Consolidated flying boat

wing. The main problem encountered in putting the passengers within the wing was the interference with the cabin by the wing bulkheads or ribs. This was overcome by putting main bulkheads at the sides of each compartment and using arched auxiliary ribs which did not impair the effective head room of the compartment.

In the design submitted by Igor Sikorsky, the hemispherical nose of the beautifully streamlined hull is necessary for stratosphere use, with a supercharged cabin. The payload of the proposed Sikorsky flying boat will be 25,000 pounds and cruising speeds may reach 300 miles an hour. *A. K.*

Speaking of Airplane Sizes!

THE mammoth and the midget, two extremes of airplane construction built in plants only a short distance apart, were both recently tested for the first time. The giant is the new Douglas luxury transport, largest

Height of this tiny engine is 3½ inches; it develops ⅐ horsepower

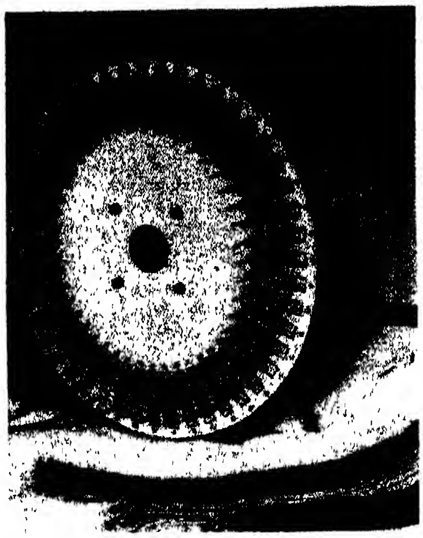
and most powerful airplane yet built. Its 65,000 pounds of streamlined metal, powered with four super-charged motors, will carry 42 passengers more than 2000 miles without refueling.

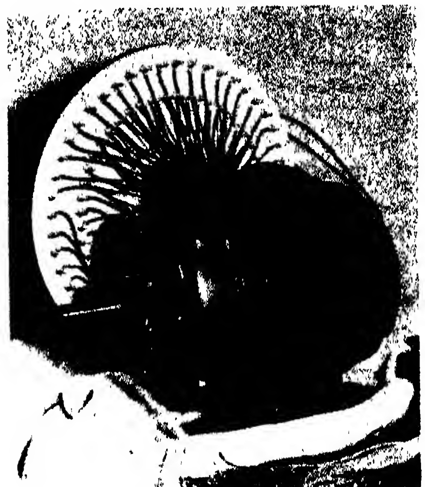
In relation to weight, the Phantom model plane, the midget mentioned, develops a flight range never remotely approached by the big Douglas or any other commercial airplane. The engine develops one seventh of one horsepower and will carry the 20-ounce plane five miles on its normal gasoline supply. If the Douglas transport could fly as far in proportion to its weight as can the Phantom, it could circle the globe ten times before landing to refuel.

The Phantom engine could be passed through an exhaust valve of the larger craft's power plant; its total height is less than 3½ inches.

Induction Motor for Educational Institutions

A PRACTICAL laboratory unit for demonstrating fundamental operation of alternating-current motors has been developed by the Westinghouse Electric & Manufacturing Company.





Front and rear views of the laboratory unit for demonstrating alternating-current motor fundamentals

This unit has the unique arrangement of a standard squirrel cage motor with a special circular terminal board. Inlaid under the top surface of the board is a representation of the 48 slots in the primary of the motor, together with numbered lines to show the actual location of the coils in the slots. The ends of these 48 stator coils are connected on the rear of the board to the studs shown as the ends of the coils when looking at the front of the board. This makes it possible to interconnect the coils in any desired manner by the use of leads or jumpers on the face of the board. The use of the numbers 1 and 101, 2 and 102, and so on, for the respective terminals at the end of each coil makes it easy to follow through when making connections. Three sets of colored leads are supplied so that groupings and phases can be identified by using different colors. This entire arrangement makes it possible to connect the motor for either two, four, six, eight, or ten poles and for either two-phase or three-phase power supply. Single-phase operation can be secured by connecting for two phase and using a capacitor (static condenser) in one phase.

Glass Cloth in Electroplating

A BAG of glass cloth has been developed to put around the anode in an electroplating bath to catch any insoluble particles that might otherwise form holes in the electroplate. Recent improvements in glass cloth permit the construction of a bag from seamless tubing woven of glass which easily resists the chemical action of the electroplating bath. The lower end of the tube is sealed by a special process so that nothing but glass is in contact with the solution. The pores of the glass cloth give sufficient electrical conductivity so that the electroplating process is not changed.—*D. H. K.*

Government Seizes Poisonous Eyelash Dye

THE first seizure under the new Federal Food, Drug, and Cosmetic Act of June 25, 1938 has been made. The United States Department of Agriculture announced recently that on the recommendation of the Food and Drug Administration, the Federal District Attorney at Milwaukee, Wisconsin, caused seizure of a consignment of "Lash Lure, The New and Improved Eyebrow and Lash Dye." The Government alleges that this product is adulterated in that it contains a poisonous or deleterious substance—a coal-tar preparation, paraphenylene diamine—which may make it injurious to users.

The product against which the Government has proceeded has an unenviable history, say Department officials. Numerous instances of severe eye injury to women who have used the product are on record, including a number of cases of total blindness. Until the passage of the new Food, Drug, and Cosmetic Act, the Government has been powerless to prevent continued traffic in this article.

Under the new Food, Drug, and Cosmetic Act the interstate shipment of dangerous cosmetics is immediately prohibited. The act, in most of its provisions, does not become effective until June 25, 1939.

New Process for Tin Plating

A NEW process for applying tin to fabricated articles of other metals consists in suspending the articles for a few minutes at 500 to 600 degrees, Centigrade, in an atmosphere consisting of a mixture of hydrogen and stannous chloride vapor. The process, called "Stannising," depends upon the reduction of stannous chloride to metallic tin by hydrogen on the surface of the metal to be coated. The thickness and other characteristics of the coating can be controlled by regulating the temperature and time of exposure.—*D. H. K.*

Adhesive Fastens Cuts When Stereotyping

A FEW months ago, after extensive research, Van Cleef Brothers, of Chicago, announced Plate-Tak as a new and economical means of attaching cuts to metal or wood bases in the process of making stereotypes. Plate-Tak, made with a special long fiber base, is an ultra-thin double adhesive tape having a very efficient adhesive coating on each of its surfaces. The successive

layers of Plate-Tak are kept from adhering to each other in the roll by means of a protective Holland cloth backing such as the manufacturer of this product has used on its rubber insulating tapes for years.

Much of the printing in the newspaper field is done from stereotypes which are the result of molding type metal in papier-mâché forms or matrices which are first given reverse impressions from original type faces and cuts or electrotypes. It has long been the practice to use small brads or tacks to hold the cuts in place during the impression process. Plate-Tak, however, is replacing this method which took considerable time and exposed the cuts to damage in the mounting operation.

When mounted with Plate-Tak, cuts or electrotypes are so securely anchored in place that the pressure roller will have absolutely no effect upon them, and because of the extreme thinness of the product, Plate-Tak will cause no bumping-up effect when the impression is made.

When it is desired to release a cut from its base, it is only necessary to pry the cut upward and roll off the Plate-Tak which always removes cleanly and with ease. Cuts, however, will not slip laterally or longitudinally while on their base.

Jungle Mosquitoes Transmit Yellow Fever

JUNGLE-BRED mosquitoes can harbor and transmit yellow fever, a Rockefeller Foundation research team at Rio de Janeiro reports in a communication to the journal, *Science.* Until recent years yellow fever was regarded as a house disease, but when in 1932 it broke out under rural and jungle conditions the existence of a jungle type of the disease became evident.

During the epidemic of this year, jungle mosquitoes were caught and allowed to bite monkeys in order to determine whether they carried and transmitted the disease. The research workers were Drs. R. A. Shannon, Loring Whitman, and Mario Franca of the Co-operative Yellow Fever Service of Brazil and the International Health Board.—*Science Service.*

FLEECE

A CENTURY ago the average annual fleece weight of sheep was only about two pounds and wool production was concentrated in the North Atlantic States. Today the annual fleece averages about eight pounds and wool growing is most important in Texas, the far West, and Ohio.

Better Use of Anti-Freeze

LOSS of anti-freeze from modern automobile engines equipped with thermostats occurs principally through leakage and overflow, according to a recent investigation made by the Ammonia Department of the Du Pont company. It was found in this investigation that the amount of methanol anti-freeze which boiled out of the radiators was only a very small fraction of the total loss and that the total loss of so volatile a material as methanol was very little different from the loss of anti-freeze materials which did not boil away. Comparison between methanol, which boils at 149 degrees, Fahrenheit, and ethylene glycol, the boiling point of which is 387 degrees, Fahrenheit, shows the losses to be very nearly the same. This similarity of behavior is accounted for by the fact that when methanol boils out of the solution some of the water boils away at the same time and also that the overflow and leakage from the system take out both methanol and water. The recommendation is that in replacing anti-freeze in cars equipped with thermostatic radiators the anti-freeze be added in solution instead of straight. Thus a radiator protected by methanol to 0 degrees, Fahrenheit, should contain originally about 27 percent methanol, and 27 percent methanol solution should be used to make up losses.—*D. H. K.*

Wooden Stamp Pad

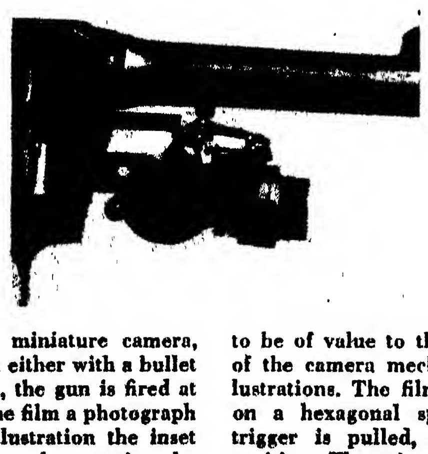
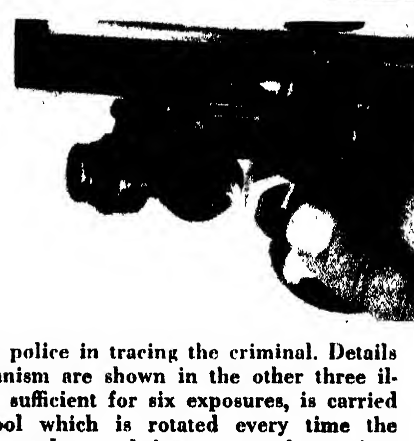
A NEW stamp pad is made of a block of wood with the grain surface exposed. Developed by the Phillips Process Company, Inc., this pad is always flat, firm, and free from lint; samples that have been tested indicate that it does not become sticky. A special ink is used that is not affected by moisture or humidity and always gives a clean, sharp, uniform impression.

Prevention of Stream Pollution

IN the iron and steel industry an outstanding problem is to prevent stream pollution by waste liquors from such operations as pickling, in which metal is commonly acid-treated. This industry, after many years of heavy expense in endeavoring to solve this problem, has recently founded, through the American Iron and Steel Institute, a fellowship at Mellon Institute of Industrial Research, in Pittsburgh, with the aim of acquiring novel ideas and attempting a definite solution just as soon as possible.

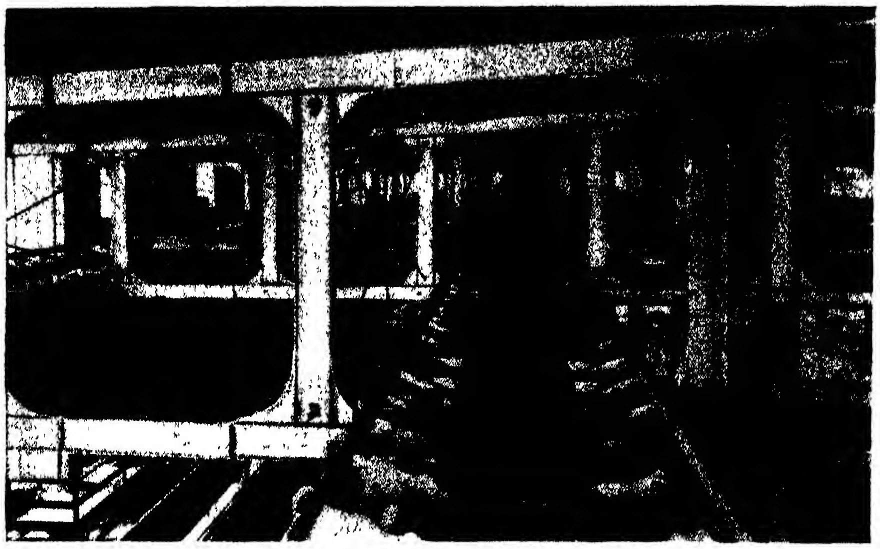
According to word from Mellon Institute, this investigation will be carried on thoroughly until concluded to the satisfaction of



Photographs from Mirzaoff

This combination of a revolver and a miniature camera, devised by A. Kurnick, should get its man either with a bullet or on sensitive film. When, as above, left, the gun is fired at an intruder, there is always recorded on the film a photograph of the law-breaker. In the top center illustration the inset shows the actual size of a contact print from the negative, the larger picture being an enlargement that gives sufficient detail to be of value to the police in tracing the criminal. Details of the camera mechanism are shown in the other three illustrations. The film, sufficient for six exposures, is carried on a hexagonal spool which is rotated every time the trigger is pulled, in order to bring a new frame into position. The trigger also operates the shutter mechanism. A single screw holds the six-ounce camera to the revolver



Industrial cars operate within the roof trusses of this new building

health and industrial authorities. It will be the objective to treat or process the waste liquor of pickling plants so as to render it entirely safe for discharging into streams, recovering from it chemicals from which useful products can be made economically.

Thousands of tons of iron and sulfuric acid are now wasted annually in various districts of this country by the lack of a suitable method of treatment, especially a procedure that can be employed on the large scale necessary in big mills; through the fellowship at Mellon Institute a concerted effort will be made to take out the chemicals in solution in the liquor and to discover uses for them.

Cars Ride Through Trusses

FARMERS throughout the rich agricultural areas which spread out like a fan at the foot of Lake Michigan will soon be driving up to the world's most completely mechanized fertilizer plant in Chicago Heights, Illinois, for scientifically blended chemicals to meet their soil conditioning needs.

Inside the International Agricultural Corporation's new plant, located a block from the Lincoln Highway, a crew of 30 men are establishing new highs in efficient operation for this industry. The plant represents the first commercial application of the portal truss designed by engineers of The Austin Company to simplify the installation of conveyors, ducts, walkways, or other facilities in otherwise useless roof areas. By eliminating all diagonals from the trusses in this all-welded structure, they have opened up 12 seven-foot passageways just below the building's roof, so that industrial cars could ride right through on tramways which are supported on and extend between the trusses.

From a structural standpoint the plant suggests many interesting future uses for the portal truss. According to Austin Company's engineers, these welded trusses open up three entirely new conveyor levels, which will be of particular value in the bulk handling of materials for chemical, paint, rubber, and food industries, not to mention many metal working fields. Tram rails can be suspended from the upper chord of the truss and stretched between trusses to carry materials through the upper portion of the portals, while tram cars operate below but still inside the portal. In addition, monorails can be installed directly on the bottom chord of the roof trusses, to operate below the truss, the lower flange of which can be adapted to serve as a rail.

LEMONS

LEMON imports have dwindled during the past 20 or 30 years to insignificant proportions, while California's production has steadily increased. During the five-year period, 1927-31, that state's average production was 6,800,000 boxes, while in the following five-year period production had stepped up to 8,100,000 boxes.

Kaufmann-Fabry photographs

Realistic outdoor effects are obtained in a skyscraper room through the use of photomurals set within frames and properly lighted, as shown above and below. In this case, the murals are part of a memorial room

Photomurals Recapture Outdoors for Memorial Room

FOURTEEN stories above the streets, in the midst of Chicago's crowded west side, a quiet room has been set apart as an unusual memorial to an unusual man.

There are no plaques, no busts, no commonplace mementoes. On a sturdy workbench is a small lathe. On the wall is its motor. Over there, on another bench, are interesting looking tools, neatly arranged. Evidently, the man who used these things was something of a philosopher and an artist, too, for clippings and maxims are tacked to the walls and window frames; from the windows one looks, not down upon a smoke-scarred city, but into what appears to be an actual shaded yard, a massive tree and at the right, a cluster of shimmering bamboos! All this 150 feet up in the air!

This skyscraper sanctuary, on one of the top floors of the University of Illinois Medical and Dental Building, is, in effect, a restoration of the California laboratory of the late Edward Hartley Angle, the father

of one of humanity's most beneficial services—orthodontia—the science of straightening teeth.

The window frames and sash are set in a false wall. The scenes observed through the panes are not real, but strikingly natural illusions produced by means of large photomurals. The views are taken from actual photographs snapped from the windows of Dr. Angle's original laboratory in Pasadena. They have been enlarged to proper scale, colored, and lighted to give an unusually realistic effect.

ARTHRITIS

THE scope of the economic problem of arthritis, one authority states, is seen by the fact that in the United States alone it causes a loss of over 7,000,000 work-weeks at an approximate cost of $200,000,000 a year.

Leakless Fountain Pen

FOR many years attempts have been made to perfect the fountain pen so that there will be no leakage at any time. The first friction cap was a notorious offender, often soiling fingers or opening in the pocket so that clothes were badly stained. Some of its shortcomings were corrected by the development of the screw cap, in which a shoulder fits tightly against the flat rim at the base of the pen point. Changes also have been made in the feed in the endeavor to prevent pumping of the liquid and flooding of the point.

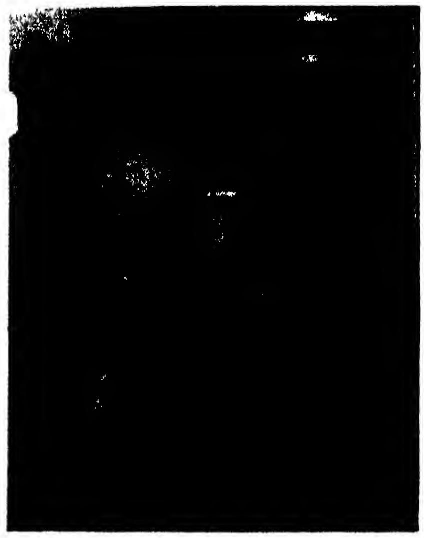
Mr. Julius L. Schnell, an inventor long associated with the development of some of the most famous pens on the market today, tackled this problem and has solved it by an ingenious yet simple invention. Mr. Schnell reasoned that when the pen is carried in the pocket, the heat of the body expands and compresses the air in both the cap and in the barrel above the level of the ink. When the pen is removed from the pocket and the cap is unscrewed, the compressed air in the barrel expands through the feed, carrying with it a certain amount of ink. Thus the pen is often flooded around the feed and point.

The invention which Mr. Schnell has made to correct this fault and on which he has received a patent consists in the insertion of a tiny perforated bushing in the side of the cap to give a free outlet for the air imprisoned within. By means of this air outlet, air escapes as fast as it expands so that there is no built-up pressure within the barrel of the pen. Tests show that this invention keeps both the point and its feed dry at all times, and it remains only for the point to be so designed that proper feeding is always assured.

Dry Cleaning Solvents Clean Coal

BY using the difference in specific gravity between coal and slate, more accurate separation and cleaner coal are being produced by a new method employing heavy synthetic liquids similar to the solvents used in dry cleaning. The liquids used are mixtures of the so-called halogenated hydrocarbons, which are several times as heavy

as water. Mixtures are made which have a specific gravity just between that of coal and of the refuse to be separated. Cracked coal as it comes from the mine is wetted with water and passed through a bath of the heavy liquid. As a result the coal separated by floating has less ash and a higher heating value. After the treatment the liquids used are easily recovered. A typical mixture could be made of pentachlorethane and tetrabromoethane.—*D. H. K.*



Passengers on the Pennsylvania Railroad's Broadway Limited have at their command a secretary with a fully equipped private office. Although the secretary will work anywhere in the train that a passenger may request, most patrons prefer the quiet of the office where letters and messages may be taken directly on a noiseless typewriter

Artificial Emeralds

IN case you plan to give your wife or fiancee an emerald necklace, you need not worry about being swindled with a man-made imitation.

It is true that chemists can make real emeralds which resemble, in many respects, those dug from the ground. But it costs far more to make them than to dig them and there are differences which can be detected by almost any jeweler or mineralogist.

A Dash of Bitters

EXCEPT for milk, most popular beverages are conspicuously bitter; some people drink only chocolate-flavored milk, which is bitter. Coffee and coffee substitutes are bitter and "burnt"; tea, maté, and cassina are bitter and astringent; cocoa is bitter and aromatic; tomato juice, citrus juices, and many manufactured soft drinks are conspicuously bitter and sour. Beer is outstandingly bitter.

There is an old belief, perhaps in part true, that bitter things stimulate appetite. Based on this theory were the "stomach bitters" of a generation ago, and possibly some of the current vogue of *hors d'œuvres* and *smörgåsbord*. Bitters are being incorporated into the flavor of some brands of sausages. A breakfast starting with bitter grapefruit, followed by bitter coffee, and perhaps with

marmalade, is satisfactory to many, although sweetness is often used to tone down the bitterness.

Perhaps the broadest interpretation of the use of bitterness is that, as one of the four fundamental tastes, it has to be included in all highly-flavored dishes or drinks. Its presence in large amounts allows increase of the other taste factors so that a strong-tasting article is possible without the taste unbalance that would be so obvious in its absence. There is a sound physiological basis for table condiments including sugar for sweetness, salt for saltiness, vinegar or lemon juice for the sour tang, and meat sauces, pepper, and mustard competing for use in imparting bitterness.—*The Industrial Bulletin* of Arthur D. Little, Inc.

A Versatile Rule and Gauge

THE simple device shown in our illustration can be used for many purposes by mechanics, toolmakers, draftsmen, experimenters, and all tool users. Its principal arm is graduated on one side with a 1/64-inch

rule and with a 1/32-inch rule, while the curved end piece is graduated in degrees so that with the auxiliary arm swung out the tool becomes a protractor. The angular end serves as a drill point gauge.

On the reverse side are a number of designs showing the manner of using this tool; also given are three tables of tap drill sizes—machine, U.S.S., and S.A.E.

This tool is made of stainless steel for long use and comes in a leather case.

School Books Not Likely to Carry Disease Germs

EVERY so often in some community comes up the question of disease germs being spread by school books. This is only natural since books handled by patients having tuberculosis, scarlet fever, diphtheria, meningitis, infantile paralysis, and kindred diseases are more than likely to get some of the germs on them either from the patient's breath in sneezing or coughing or from his hands.

A pretty clean bill for ordinary school books, however, and some recommendations on books in general, are now presented by Arthur H. Bryan of the science department of Baltimore City College. He collected pages from very old and from newer school

books, most of which had been recently used by students, cut up the pages, soaked them and shook them in sterile water for from 15 minutes to one hour, and then transferred some of the water to germ-growth media to get some idea of how many germs actually had been on the pages of the books.

Ordinary school books, surprisingly enough, showed very few germs and those mostly of a harmless variety. Books that are not too old or dilapidated, he concluded, are not serious carriers of infectious diseases. School books that are kept for some time before being redistributed do not seem to have many living disease germs on their pages. Old books with visible dirt and grime smeared over their pages are capable of harboring many more disease germs than clean or new school books.

Mr. Bryan recommends that old school books which are frequently exchanged should be opened up and sunned for several hours. Books used by sick children should not be handed out to other students immediately (most germs die or lose their virulence if kept away from body tissues for a while). Books which are dilapidated, out of date, and filthy with grime should be destroyed. Books coming back from quarantined homes should be destroyed or held for several months before redistribution.—*Science Service.*

DIESEL OIL TAX

THIRTY-SIX states now tax Diesel fuel when it is used in the propulsion of motor vehicles on the highways.

Carriers of Radioactivity

THE high cost of radium and the intensity of its radiation have encouraged research workers to seek material on which radium or radium emanations can be spread in such a way as to dilute them without interfering with their valuable qualities. Investigators in Prague, Czechoslovakia, have recently found that silica gel combined with heavy metals and alkaline earth hydroxides yield compounds having high absorbing ability for radioactive salts and yielding stable emanations. Good results have been obtained with the hydroxides of magnesium, manganese, cobalt, aluminum, and nickel combined with iron and mixed with silica gel to form an absorbing base for radioactive salts. The effect of this is to give a more accurate control of the application of radiations of radium for medical use.—*D. H. K.*

U. S. Fourth in Number of Nobel Prize Winners

THE United States ranks fourth in the number of Nobel Prize winners, it is shown in a survey completed by Prof. Harrison Hale of the University of Arkansas for the American Chemical Society. Eighteen Americans have been honored with the prize since it was first inaugurated in 1901 under the will of Alfred Nobel, discoverer of dynamite.

Germany leads the list of nations with 37

winners, England comes second with 23.5 winners, and France is third with 20.5. The half winners merely mean that some years the prize has been split between two men.

The Nobel Prize, granted for outstanding achievement in physics, chemistry, medicine, literature, and on behalf of international peace, has changed in its award pattern in the last decade, says Prof. Hale.

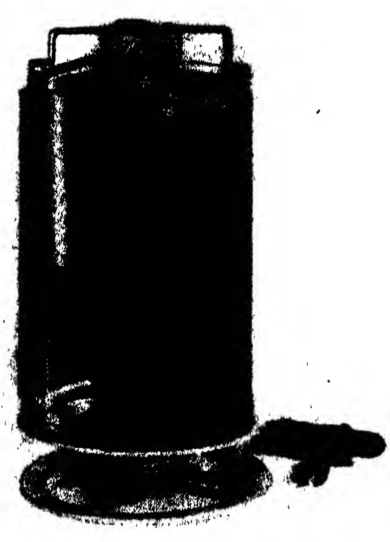
In prizes awarded in the last 10 years England and the United States lead with 10 each. Germany comes next with 9.5, and France has dropped behind with only four winners. During this time the relative position of the United States has improved 63 percent, a change mainly due to the improving caliber of American scientific achievements. A similar improvement in the next decade would raise the United States to second place.—*Science Service.*

Controlling Volatility of Perfume Oils

Manufacturers of the odorous oils of cedar wood and cedar leaf have borrowed from the technique of the formulators of lacquer solvents to increase the useful life of their oils. The oils of cedar wood and cedar leaf are used in polishes, coatings, insecticides, and disinfectants, but on exposure to air they soon evaporate and lose their usefulness. Mixtures of the two have a longer life than either alone, but by the addition of certain resins and other materials, the rate of evaporation of either of the oils or a mixture of them can be made materially slower. In this way the life of cedar-treated moth-proof containers can be materially lengthened.—*D. H. K.*

Blueprint Kit is Portable

Often the engineer or architect wishes to make numbers of reproductions from small drawings or specification sheets. Lacking a machine for making them, he must wait until they can be turned out for him by some professional blueprint organization. To solve this problem the Vandenwood Company has developed what they call the Baby Blue Personal Blueprint Kit. The maximum size prints made with this machine measure 9 by 18 inches.



For office blueprinting jobs

This outfit consists of the blueprinting unit proper, which is a glass cylinder mounted on a cast aluminum base and carrying two conventional light bulbs. Operation is on a 110-volt lighting circuit. The tracing and sensitized paper are wrapped around the outside of the cylinder and held in place by a Fabrikoid shade, one end of which is fixed and the other rolled on a roller of a special design. Operation is by means of fixed cables at top and bottom.

This machine is not continuous. When tracing and paper are in place, a conveniently located switch in the extension cord is manually operated and exposure is timed in accordance with instructions. After exposure the blueprint is washed and fixed in pans which are supplied with the kit. Fixing solution and a rubber roller are also provided.

WARNING

AN abdominal pain (stomach ache) that lasts over four hours is usually serious. In such cases—*don't* take laxatives or physics; *don't* eat or drink; *do* call your doctor.

Traveling Oven Temperature Recorder

A NEW portable recording thermometer for use in traveling baking ovens, finishing ovens, enameling ovens, and so on, has been developed by The Bristol Company.

The instrument passes through the oven on the conveyor with the "work" and gives a continuous record of the temperatures to which the heated product is subjected as it passes through the oven. The record is made on an eight-inch round chart arranged for 24-hour or seven-day clock rotation. These thermometers are especially useful in large enameling ovens in plants where electric and gas heaters and ice refrigerators are manufactured. They are also extensively used in ovens for treating the finish on automobile bodies. In this type of work they are valuable in maintaining the proper temperature for the color of the finish desired.

Fire Hazard From Oil on Water

FIRE hazard from oil or gasoline spilled on water over which it can spread freely is much less serious than has been ordinarily supposed. A recent thorough investigation of the flammability characteristics of gasoline and oils under such circumstances, as reported in *Oil and Gas Journal*, led to the following conclusions:

1. Only gasoline and some light naphthas will ignite or burn.
2. Tremendous quantities of gasoline are required to cover even a few acres of water.
3. Gasoline weathers rapidly when exposed in thin films and will not ignite after a short exposure.
4. Gasoline will not ignite other oils such as kerosene either when mixed with them or lying adjacent to them on the surface of the water.

Apparently the effect of the water in keeping the oil layer cool, the action of moving

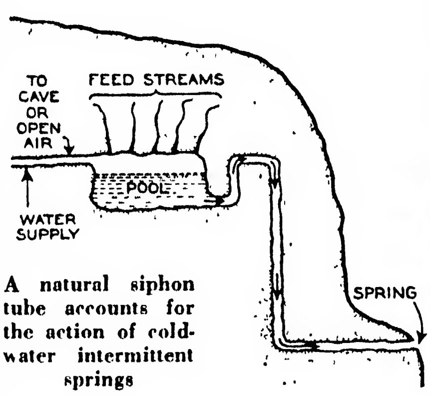
air in diluting and removing the more flammable constituents of the oil, and the thinness of the oil layer when it is free to spread over the water surface are important factors in the change of its properties and behavior.

The extreme thinness of films of oil on water is seldom realized. Gasoline, for example, may yield a film from 7 to 15 thousandths of an inch in maximum thickness. To form such a film over a square mile of water surface would require between 122 and 261 thousand gallons of gasoline! Heavier oils form thicker films (up to 50 thousandths of an inch thick) and one hundred tank car loads of them are required to form such a film over a square mile of water.

All of which explains why oil fires are not more destructive in times and areas of high floods.—*D. H. K.*

Intermittent Springs

HERE and there occurs a spring that flows a while and stops a while, flows a while and stops a while, day in and day out, year in and year out, to the mental confusion of those who, not knowing their cause, invent explanations of them as fanciful as a medieval gnome or hobgoblin. There are two kinds of these intermittent springs, as explained by the meteorological physicist,



A natural siphon tube accounts for the action of cold-water intermittent springs

Prof. W. J. Humphreys, of the United States Weather Bureau at Washington, D. C., in the *Monthly Weather Review*, namely, the cold-water kind which every physicist understands, and the hot-water kind that not even the chemist fully understands in every particular.

The flow of the cold intermittent spring is just the emptying of an underground, air-connected (essential for rapid outflow), water cavity by a natural siphon tube, as shown in the diagram. Obviously, when the reservoir is emptied to the level of the siphon intake the flow ceases—the spring goes dry and stays dry until the reservoir fills again to the level of the highest bend in the tube, whereupon the flow and the stop occur again as before, over and over without end.

The hot-water type, confined to volcanic regions, commonly is called a geyser, Professor Humphreys continues, even when it just mildly overflows. Its intermittent spurts appear to be the repeated blowing out by steam of an underground reservoir that as often fills up again. Where all this water comes from and how it gets into the steam chamber are not known to the complete satisfaction of everyone. It is easy enough to make a laboratory geyser that works perfectly, but that does not prove that Nature made hers on the same plan—she is very resourceful.

Conducted by JACOB DESCHIN

A Record of Growth

THIS is the story of a yam and how it sprouted—and *how.* After we had nursed two along in this way and found them worth their care, it occurred to the photographer of the family to make a step-by-step (or nearly so) record. The series of five pictures here reproduced is a partial result. It is obvious that all were taken by daylight.

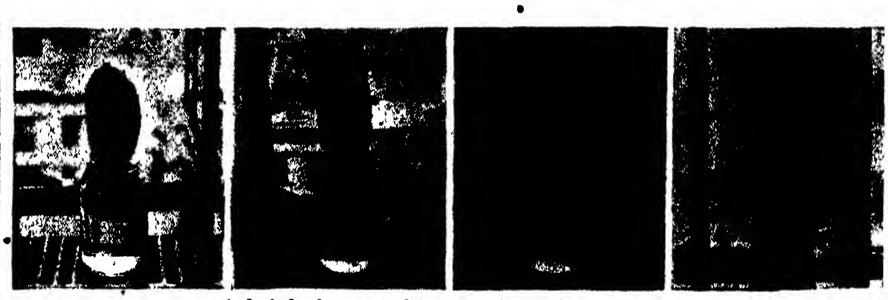
The first three photographs were made chiefly to display the roots to the best advantage, although in the third case a cardboard reflector was employed to show some detail on the camera side of the potato. The best effect was obtained with the camera tilted downward in order that relatively dark areas rather than the sky itself might serve for backgrounds. The fourth shows the "transplanted" potato and the last picture in the series gives some idea of the possibilities of this "poor man's fernery." But you should see it now as the runners extend the length of a six-foot window sill!

For those of our readers who may not be familiar with this type of plant, it must be stated that the feat is accomplished with an ordinary yam purchased at the grocer's. The yam is inserted root-end first in a preserve jar full of water and the water changed daily. After a few days the roots start "coming out" and some time afterward little growths push out of the upper end of the potato. The next step is to transplant the potato to a pot full of top soil, water daily and watch it grow, carefully arranging the vines in the way you want them to grow.

In making such a photographic series as this, or a similar one, the temptation arises to make too many pictures, some of which are for practical visual purposes little more than duplicates of each other. While it is both instructive and interesting to have as complete a pictorial record of the development of the plant as possible, the individual pictures should be limited to those which show real differences.

In the lighting of the illustrations repro-

(*Please turn to page* 210)



A brief photographic record of plant growth

The full-grown plant

Third Annual
SCIENTIFIC AMERICAN
Amateur Photography Contest

$225 IN PRIZES

TO present more opportunity to a greater number of amateur photographers, Scientific American's Third Annual Photography Contest has been planned on an entirely different basis from former contests. Contestants may enter prints in any or all of three separate divisions, thereby being assured that their work will be in competition only with similar efforts submitted by others.

Three Divisions To Enter

Division 1. **Human**—including portraits and other camera studies of people.
Division 2. **Landscapes**—including all scenic views, close-ups of parts of landscapes, seascapes, and so on.
Division 3. **Science and Industry**—including laboratory and factory scenes, technical aviation and natural history photography, and so on.

In each division the prizes awarded will be:
First Prize $50
Second Prize $25
Five Honorable Mentions, Each to Receive a One-Year Subscription to Scientific American

The scope of each one of the divisions has been purposely generalized to a certain extent in order to permit the individual amateur to apply his own ingenuity to the interpretation which he will achieve with his photographic study.

The rules are few and simple, but please read and abide by them to insure against disqualification.

RULES OF THE CONTEST

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14. Prints need not be mounted, but may be at the contestant's option.

3. Photographs must be submitted by first class mail, packed properly to protect the prints.

4. Each entry must have the following data written on the back of the print or mount: Name and address of contestant, type of camera, and film used.

5. Contestants may submit only one print in each group, but may enter any or all groups.

6. Prints must be in black and white. Color photographs are not eligible.

7. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

8. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

9. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by January 2, 1939. Results will be announced in our issue dated March 1939.

12. This contest is open to all amateur photographers who are not in the employ of Scientific American.

The judges:
McClelland Barclay, artist
Robert Yarnall Richie, commercial photographer
Ivan Dmitri, artist and photographer

Address All Entries to

PHOTOGRAPH CONTEST EDITOR
SCIENTIFIC AMERICAN
24 West 40th Street, New York, N. Y.

duced, it must be confessed that had the photographer not been quite so lazy (at the time), he might have improved the job to some extent by using some kind of lighting from the inside of the room as well as daylight. This lighting, when used, is sometimes effectively furnished with a white reflector properly angled. If artificial lighting is used this should be carefully done—just enough to do the job yet soft enough not to overbalance the daylighting. In the case of such pictures as the first three of the series presented, it is better to use only daylight and thus obtain the full effect of the desired translucence. Many subjects, too, may be photographed outdoors and in that case, because of the tremendous diffusion of the lighting afforded by the great dome of the sky, lighting difficulties such as these will not arise. Incidentally, it must not be overlooked that the employment of a reflector with outdoor subjects has its uses just as effectively as indoors, although the contrast between the highlights and the shadows may not be as great as those obtaining with indoor window-sill photography.

Shoot the Troubadours

THE troubadours of the city streets may sometimes prove annoying to one's musical sensibilities, but they frequently offer picture possibilities exciting enough

"Pied Piper"

to offer ample compensation. This department found such a subject in the "Pied Piper." The children trailing after him furnished the idea and completed the subject. The diagonal composition provided the effect of forward movement as well as a generally pleasing arrangement.

Rolleiflex Salon on Tour

FOLLOWING its exhibition in New York City this year, the Third Rolleiflex-Rolleicord Salon is now on tour throughout the country. The show has been seen in San Francisco, Los Angeles, Hollywood, Omaha, and Denver, and is scheduled to be shown during September in Boston, Buffalo, and Cleveland; in October in Detroit, Chicago, St. Louis, and Louisville; and in November in Indianapolis, Cincinnati, Pittsburgh, Washington, Baltimore, and Philadelphia. Herbert Peerscke, of Francke & Heidecke, is in charge of the traveling salon of 250 selected prints.

Bargain Counters

TAKE a tip from the housewife and look for the specials and the bargains in cameras and accessories. With many items it

really makes little difference whether the equipment or photographic supply is purchased new or used or shopworn; just so long as it will give satisfactory service it is practically "as good as new." And the difference in the price is often considerable. The advertisements of the various photographic dealers and distributors are worth scanning periodically, but a better plan, because many items are too small to warrant the cost of inclusion in an advertisement, is to visit your dealer at frequent intervals, if only for "just looking around." It is on such occasions that sometimes you will run across some long-wanted item that you felt you could not afford at the regular price but which now, at the greatly reduced price, brings it well within reach of even a lean pocketbook.

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

New Films

THREE films designed for greater light sensitivity and finer grain are now on the market under the names Kodak Plus X Panchromatic, Panatomic X, and Kodak Super-XX Panchromatic films. They are made in 35-mm and 828 sizes. Recommended for general use in miniature cameras, Kodak Plus-X Panchromatic is declared to have about twice the speed of, and as fine grain as, Kodak Panatomic and about 50 percent greater speed than Kodak 35-mm Supersensitive Panchromatic. For Panatomic X, said to possess even finer grain than the fine grain of the original Panatomic film, though without any increase in speed over the latter, the manufacturers claim the possibility of making enlargements "of a size which will exhaust the sharpness of images before graininess is visible."

Kodak Super-XX Panchromatic is reported to have about four times the speed of Kodak Panatomic and more than twice the speed of Kodak Super-X Panchromatic, both in sunlight and artificial light, with a finer grain than that possessed by "any other film anywhere near this speed." For maximum emulsion speed the manufacturers recommend full development in Kodak Developer D-76.

The manufacturers further make the statement that "it is possible to overexpose these new films to the extent of 100 times the minimum exposure necessary to provide a reasonably good print."

Agfa Isopan New Type film, available in all standard sizes on safety and nitrate base, replaces Isopan film, which it doubles in speed. The new film possesses extremely fine grain, according to the manufacturers, as well as brilliant gradation and full color sensitivity.

Bearing a similarity to Agfa Superpan Portrait in gradation and color sensitivity, a new cut film, Triple S Pan, is available in standard cut-film sizes of 3¼ by 4¼ inches, 9 by 12 cm, 4 by 5 and 8 by 10 inches. The Triple S Pan, say the makers, "provides a speed advantage of one full lens stop over

Superpan Portrait and Supersensitive Panchromatic cut films." The price of this new Agfa film is approximately 10 percent higher than Superpan Portrait cut film.

Formula X33

DECLARED to embody "entirely new developing agents and chemicals" and possessing "qualifications and chemical performance hitherto never attained in any other product," Formula X33 ($1.85 a quart) is the newest fine-grain developer to appear with claims of proved performance at temperatures as high as 85 degrees. The following synopsis of the laboratory report tells the complete story: Temperature range --may be used for developing negatives at temperatures ranging from 65 degrees to 85 degrees, Fahrenheit, with perfect safety. Stability--stable in all climates; not affected by repeated temperature changes; does not oxidize readily through constant use or exposure to air. Non-staining—does not stain the hands, the reducing agents in the developer being comparatively non-toxic. Development—at normal temperature and in cool weather, rinse of a minute or two between development and fixation is sufficient; when temperature of developer and room is above 78 degrees, good short-stop bath required. Fixation—temperature of the fixing bath has no effect on the results if it does not exceed 80 degrees. Exposure—films should be exposed at their maximum rated speeds. Fine grain—negatives developed in Formula X33 are brilliant and free of fog; there is a wealth of detail in the shadows; negatives reproduce a well balanced photographic scale; the size of the grain of the developed image is very fine, the clumping together of silver particles being entirely eliminated due to the very even distribution of the silver grains. Economy—32 ounces of stock solution will develop 20 rolls of 36-exposure, 35-mm film or its equivalent of surface area in other sizes. Character of negatives—clear and of a neutral grey-black in color. Storage of developer—may be kept any place irrespective of prevailing temperatures or climates for indefinite periods in its original stoppered bottle; does not need chilling before use unless its temperature exceeds 85 degrees.

New Speedgun Release

DESIGNED for use with cameras that focus from the front bed, a new release mechanism for the Mendelsohn Speedgun (release, $2.50) has been introduced to speed the transfer of the fingers from focusing knob to flash release. The plunger of a standard cable release attaches to the bed of the camera in such a manner that one hand operates both the focusing knob and the cable release button. The other end of the release screws into a small socket in the body of the gun. In use, the camera is focused in the regular way, and the shutter and flash are set off by touching the button of the conveniently placed cable release.

Photometer

THE M.C.M. Photometer ($4.85) was designed primarily to eliminate guesswork, and the nuisance of test strips, from the enlarging process. It can also be used to determine the density scale of any negative and

thus gives a definite indication of the proper grade of paper to use in each case.

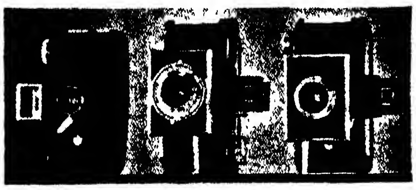
It makes use of the well known "grease spot" laboratory method of light measurement. Operating directly from any 110 volt A.C. or D.C. power source, it is simple and easy to use as it reads directly in seconds of exposure.

Zephyr Camera

A 35-mm camera in the low price field, the Zephyr Candid Camera is offered in two models, each equipped with a two-inch Wollensak lens, one $f/2.9$ ($29.50), the other $f/3.5$ ($22.50). An ever-eady leather carrying case ($4.95) is available. The Zephyr includes the following specifications: Balanced focal plane shutter; speeds from 1/25th to 1/500th, as well as time and bulb; diaphragm stops ranging from $f/3.5$ (or $f/2.9$) to $f/16$, hard aluminum alloy case, leather covered, with brushed aluminum trimmings; automatic film counter; accommodates standard 36-exposure 35-mm film spools; Wollensak telescopic view finder; winder lock, built-in range finder attachment; tripod screw bush in base; finger and cable release.

Three Kodak Bantams

Kodak Bantams $f/8$ ($4.75), $f/5.6$ ($16.50) and $f/4.5$ ($27.50) are announced as the latest members in the Bantam line. The $f/4.5$ has a body and back of die-cast aluminum covered with black morocco-grain Kodadur, a self-erecting front, revolving lens mount focusing from 4 feet to



infinity, and lens openings down to $f/16$, with shutter speeds from 1/25th to 1/200th, including time and bulb. The $f/5.6$, with lens openings to $f/16$, has shutter speeds to 1/100th, with focusing from 4 feet to infinity, self-erecting front, folding eye-level optical view finder, and automatic film centering. The $f/8$ supersedes the Kodak Bantam with doublet lens. The front comes into position at the touch of a button; a folding open-frame eye-level view finder is provided and film frames are automatically centered. The $f/8$ is a fixed-focus camera giving sharp negatives from five feet to infinity. With an 8A Portrait Attachment snapshots may be made at 2½ feet.

Each of the three cameras loads with 8-exposure rolls in the 828 sizes and produces negatives 28 by 40-mm.

Projection Apparatus

The Diafant Model 1 ($69) and the Diafant Model O ($49) projectors are now available in this country. The former has a projection system based on a 250-watt bulb and is equipped with a polished glass reflector, three 60-mm fixed condensers, and a heat absorption filter. The lens is an Omar $f/3.5$, 100-mm focus and the front assembly re-

volves to permit the projection of either vertical or horizontal pictures. Accommodating either film strips or 2 by 2 inch slides, the Diafant Model 1 is provided with a shielded reading window for identification of slides during projection.

The Diafant Model O uses a 100-watt bulb and is somewhat smaller than the Model 1. All other details correspond with those of the larger model, with the exception that the lens is a 90-mm Parastigmat $f/4.5$.

Saymon-Brown Range Finder

THE Saymon-Brown Range Finder ($4.75), designed for use with cameras not equipped with a built-in range-finder focusing device, is declared by its makers to be of "fool-proof, shock-proof construction." The range finder is provided with a distance disk on which the numbers are clean-cut. Finished in black and chrome, the device has an extension foot for attaching to a camera and is provided with a leather case. The distances range from 2 feet 6 inches to infinity.

Pic-Sharp

DESIGNED for facilitating ground-glass focusing, Pic-Sharp is the latest aid to photographers who find difficulty in focusing. The new device is made of soft pliable rubber, in the center of which is a magnifier lens that triples the size of the image. The manufacturers claim for the Pic-Sharp that because of its design it fits easily into the pocket or kit, cannot scratch ground glass or other equipment, and may be accidentally dropped or stepped on without breaking.

Federal Fixed Focus Enlarger

A LOW-PRICED enlarger of the fixed focus type is offered in the Federal Model No. 835 Automatic Fixed Focus Enlarger ($12.50). A double frame 35-mm negative strip is placed in the open view negative carrier, the switch pressed and a 3½ by 5 inch enlarged image is visible on the ground-glass plate. A sheet of 3½ by 5 or 2½ by 3½ inch bromide paper is inserted into the holder under the ground-glass plate. The switch is held down from five to ten seconds, depending on the density of the negative and the paper contrast used, and the enlargement is ready for development. Any bromide paper may be used with the Federal, the manufacturers recommending the purchase of paper in 5 by 7 inch sizes. For cutting the paper, a paper slitter is supplied with the enlarger.

The Federal enlarger is operated on either A.C. or D.C., and may be used as a viewer for colored transparencies if desired. The enlarger includes a corrected achromatic lens system and a parabolic reflector for even distribution of light.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. In a recent issue (July, 1938) you answered a query as to finding the depth of focus for various distances and stops. In your reply you said that to find the hyperfocal point one must "Multiply the focal length by itself; multiply the result by the circle of confusion (in your case 1/250. . . .); divide the result by the *f* value of the lens . . . multiplied by 12 to obtain a result in feet instead of inches." First, in what units is the focal length given, cm or inches? And *what* of the circle of confusion is 1/250—the radius, diameter, or circumference—and in what units is it given? And why, in the example worked, was the focal length $(7.25)^2$ multiplied by 250 instead of 1/250? The *f* value of a lens, as I understand it, is the ratio of its focal length to its diameter, and since this is dimensionless, how can multiplying it by 12 turn it into feet? Will you please set me straight on this matter?—*C. J. LaF.*

A. Perhaps we took too much for granted, but we wrote on the assumption that in this country the focal length of a lens, when not otherwise stated, is generally understood to be expressed in inches. The same applies to the circle of confusion measurement, which is 1/250th of an inch, the diameter of the circle or disk of light known as the circle of confusion, employed in calculating the hyperfocal distance in this particular case. The figure 250 was used because, since all the measurements were expressed in inches, the reciprocal of the circle of confusion (1/250) is 250. The multiplication of the *f* value by 12 was used merely as a convenience in arriving at the measurement in feet. The same result may be obtained by ignoring this part of the calculation, getting a result in inches and then dividing the latter by 12.

Q. Is the range finder on a Leica camera adjusted to show the focal distance from the object to the film plane or is it adjusted to show the distance to some other point on the camera? The majority of larger cameras figure the distance to the lens, do they not?—C. B. S.

A. If the distance indicated were to "some other point on the camera," the whole purpose of the range finder would be defeated. This purpose is to focus an object sharply on the plane where the film surface lies. When the subject is sharp in the range finder, in your case when the "two images" coincide and are one, the subject will be rendered sharp on the film emulsion when the latter is exposed to the light reflected from the subject.

Q. Would you please tell me if it is possible to make full color movies by using Kodachrome film in a Univex 8-mm movie camera equipped with an *f*/5.6 lens?—K. B.

A. Kodachrome film is not at present available in loadings for the 8-mm Univex. If it were, however, there would be nothing to prevent your using it in the Univex equipped with the *f*/5.6 lens, provided there is sufficient light intensity to permit taking motion pictures at the normal movie-taking speed.

Q. What is meant by the term "local intensification?"—A. L.

A. This refers to the use of a chemical solution for building up density in a selected part or parts of an under-developed negative so that these portions may print satisfactorily.

Q. I have a 1200-rpm synchronous motor which, I believe, is just the thing with which to measure shutter speeds of cameras. My idea is to fasten a piece of wood at right angles to the shaft (balanced, of course), with a flashlight bulb on the end of it. I would then take pictures of the light revolving and from these calculate the speed of the shutter very simply. What accuracy could be expected?—G. B.

A. Shutter speed testers devised by amateur workers are usually based on the use of a device that revolves at a known speed and employs some luminous point to record the results of the test for each shutter speed. The length of the arc formed by the revolving light is related to the number of revolutions made by the rotating device in one second. The measurement of the arc, therefore, provides the answer to the shutter's efficiency with regard to any of the marked speeds. The condition of continuous movement at a known speed that will not vary is fulfilled by the motor you mention and the use of a revolving bulb provides the luminous point or light source. Your prob-

lem is to select a tiny bulb and an extremely light-weight support for the bulb in order to keep drag down to a minimum. If you can effect such an arrangement, the resulting tests should prove fairly accurate.

***Q.* Enclosed are 14 prints from negatives I have taken in different parts of the world, which if suitable I wish to offer for publication along with the necessary notes. They are submitted for comment as to their merits for reproduction only; I would like to know what type of negative and print is most desirable for that purpose.—J. D. M.**

A. It is difficult to tell from the obviously rushed prints you have submitted just what type of negative they were printed from. As for the subject-matter, it will stand the best chance if accompanied by an article and submitted to a magazine or newspaper feature section which is in the market for this type of material; that is, travel. A negative with good detail in the shadows and enlarged to at least 5 by 7 or preferably 8 by 10 inches on glossy paper with the general tone on the light side will please the editor no end, provided, of course, that the subject is something he can use.

***Q.* Can you give me a simple formula for cleaning trays?—F. X. R.**

A. For cleaning all ordinary photographic stains from trays and graduates, the following solution has been found successful: one ounce of sulfuric acid added to ten ounces of a saturated solution of potassium bichromate.

Q.* Several weeks ago I bought a set of color filters for my camera. I have been discouraged with the results, being unable to determine the correct exposure for the different filters. I have always been very careful in calculating exposure times, using a meter and considering the factors indicated in the filter set instructions. But this seems to be of no avail as some of the filters cause over-exposure and some under. My set consists of a holder and five optical glass filters.—*S. A.

A. We are not familiar with the filter set you mention and would suggest that if you do not find the given factors to be accurate you write to the manufacturers or distributors of the filter set, state your experience with their factors when using certain films and ask for a revised table. Filters do have different effects on different makes of films and the best way to find the proper factors for given films is to write to the service department of the manufacturers of the film. Another way, although more laborious, is to make tests on your own and determine the proper factors for yourself.

***Q.* I have a 16-mm motion picture camera which is an old timer. On the film formerly used the perforation track ran down the middle. Can you tell me where I may purchase 16-mm film with the track in the middle?—W. A. H.**

A. This film is no longer available. While it may be had perforated in the middle on special order from film manufacturers, the minimum quantity which the makers would be willing to supply would probably be much more than you would want for amateur purposes.

Books

SELECTED BY THE EDITORS

EXPERIMENTAL TELEPATHY

By René Warcollier

A TRANSLATION from published accounts of the experimental work of the author over a 15-year period, published in this country by the Boston Society for Psychic Research with which he had close relations. The numerous illustrations include many which are presented in pairs, of which the first in each instance shows the drawing transmitted and the second the image perceived. Many of these show striking correspondence. The author attempts an explanation of the nature of telepathy and discusses the subject in other respects, in addition to giving the accounts of the actual experiments. (290 pages, 5¾ by 8½ inches, illustrated.)—$3.70 postpaid.—*A. G. I.*

GUINEA PIGS AND BUGBEARS

By G. L. Eskew

AN open attack on Consumers' Research and on Kallett and Schlink, the authors of the widely-read book "100,000,000 Guinea Pigs." While many cooler heads thought that book greatly overdid a job that needed doing, it being as sensational and exaggerated a book as your typical crusader can usually be depended on to produce, there isn't much more to be said for the present counterblast to it. Even so, "Guinea Pigs and Bugbears" makes interesting reading and may lead the previous reader of "100,000,000 Guinea Pigs" to strike an average between two extremes. (269 pages, 6 by 8½ inches, illustrated.)—$1.65 postpaid.—*A. G. I.*

BOTH SIDES OF THE MICROPHONE, TRAINING FOR THE RADIO

By John S. Hayes and Horace J. Gardner

AVERAGE radio listeners are familiar only with the receiving end of radio broadcasting. Here, however, they can find a compact story of the other side of the microphone—the program department, the musical division, sound effects, the announcer, and so on. Those who are interested in broadcasting from a vocational angle will appreciate the succinct information which the authors present. (180 pages, 5¼ by 7¾ inches, unillustrated.)—$1.40 postpaid.—*A. P. P.*

THE CONQUEST OF CIVILIZATION

By James Henry Breasted, Ph.D., LL.D., D.Litt.

A NEW edition, fully revised, of an account of the earliest civilization in Egypt, Western Asia, Greece and Rome. To call this a history would be to mislead the reader and do the book an injustice. If only books like this had been used in the schools of a generation ago, the word history would not make most middle-aged people of today shy off the subject but like it instead. The smooth flow and charm of Breasted's style, his own dislike of the old-fashioned boredom of dates, lists of kings and battles, and the vividness and humanness of his account, taken with his own pre-eminence, make this a book capable of wiping off the history hater's hate. It doesn't even look like a text book. This reviewer has read it (in the earlier edition) three times. (669 pages, 5½ by 8½ inches, 215 illustrations.)—$4.20 postpaid.—*A. G. I.*

TRANE AIR-CONDITIONING MANUAL

ASSEMBLED and presented in this one large volume is a complete course in air conditioning, beginning with a study of heat fundamentals and continuing through more technical and mathematical aspects of a conditioned air supply. The facts are based upon the experience of one large company which is one of the pioneers in this new science of comfort. This volume is rather on the technical side including, as it does, more mathematics than the layman would ordinarily like to work with, and numerous tables. It is recommended especially for air-conditioning engineers. (333 pages, 8½ by 11¼.)—$5.00 postpaid.—*F. D. M.*

DUODECIMAL ARITHMETIC

By George S. Terry

A LARGE volume containing full instructions for using the duodecimal system of arithmetic, with extensive duodecimal tables (accompanied by examples of their use) of square and cube roots, reciprocals, logarithms and trigonometric functions in terms of the duodecimal circle; together with shorter tables of some of the higher mathematical functions. To duodecimal devotees this work will long be a landmark. (407 pages, 9¼ by 11½ inches.)—$7.75 postpaid. —*A. G. I.*

MASTER BUILDERS OF SIXTY CENTURIES

By John Anderson Miller

"WHEN Moung Tien started work on the Great Wall he had at his disposal a force of about three hundred thousand men. It soon became evident that a force of this size would not be able to build a wall of the desired type and length in less than about a hundred years. So the system was changed. Moung Tien laid out the whole course of the wall across North China and work was then begun at numerous places along this course instead of proceeding step by step from the original starting point."

This paragraph, taken almost at random from the book, serves to indicate the manner in which the author has brought to life the details of construction of many great monuments of man's genius. In this volume he sets the reader down at the scene of the job and almost allows him to see with his own eyes the essential details of the construction work. The result is a fascinating study of the construction of the Pyramids, the Great Wall of China, Roman aqueducts, Roman roads, cities of the Mayas, Crusaders' castles, dykes of the Netherlands, subways, bridges, the Panama Canal, and other great projects. Midnight oil will be burned by many who expect to read this book in sections but wind up by reading it all at once. (315 pages, 5½ by 8½.)—$3.15 postpaid. —*F. D. M.*

LIGHT

By Vivian T. Saunders, M. A.

A COMPACT treatise on elementary optics, not for entertainment but for study, dealing in respective chapters with reflection, refraction, lenses, reflection at spherical surfaces, optical instruments, refractometry, color, photometry, light velocity, interference, diffraction, and polarization. It is intended for use in the English schools, is thorough as far as it goes (a good, solid elementary grounding) and employs high-school geometry and algebra throughout. (328 pages, 4½ by 7 inches, 196 illustrations.)—$2.65 postpaid.—*A. G. I.*

HEREDITY AND POLITICS

By J. B. S. Haldane, Professor of Biometry, University of London

A NOTED biologist discusses some of the central dogmas of eugenics (using the term largely as it is conceived by politicians and by a part of the public) and shows the fallacies on which some of them are premised. The futility of the sterilization laws of this country and Germany, with their intention beneficial but their scientific basis faulty; the fallacy that all men are created equal, and the causes of human inequality; the fallacy of racial superiority; the questions of race mixture and of other race problems—these and cognate subjects are discussed directly and clearly and their truly scientific aspects are explained. Just such questions are daily debated at social gatherings and in Pullman car smoking rooms, usually with more heat than light and often with perfect logic based, however, on faulty premises. This book states the premises according to science and not according to politicians, self-admiring nationalities, dictators, and other well meaning, wishful, or end-seeking thinkers. (202 pages, 5 by 8 inches, 14 illustrations.)—$2.65 postpaid.—*A. G. I.*

FOR OTHER BOOKS YOU WANT, SEE PAGE 204

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Figure 1: Kelley's attractive portable

THREE telescopes constructed by our readers, which win deserved applause for excellence, are shown in Figures 1, 2, and 3.

Finished is the word for the 6" portable 'scope shown in Figure 1, made by Emir Kelley, of South Brownsville in the southwestern corner of Pennsylvania. All its parts are of instrument-maker grade of workmanship, as the photograph shows. A Hindle "crocodile-type" grinding machine ("ATM," 4th ed., p. 235), also made by Kelley, is equally finished in appearance and its description will be published at some later date. Kelley's telescope has an eyepiece adapter that rotates 90° over the top of the tube in a transverse slot. It also has a weight-driven clock that will run 3½ hours with one setting.

We detailed one of our supersleuths to dig up more data about Kelley, as we suspected him of being something of an inventive genius, and this secret operative reports that he is the senior partner of Kelley and Stewart, makers of auto jacks and cranes; also that he owns a famous grandfather clock of his own design and make, which not only tells the time and the moon's phases, but is a true Gentleman's Annual Best Friend and Life Preserver. Almost any married man will recall the awful feeling experienced when, one day of the year and generally along toward bedtime, his wife hands him a calendar and stands waiting before him with lips tight drawn; whereupon he is at first puzzled, then leaps suddenly from his chair, passes a trembling hand across a flushed brow and begins thinking fast for alibis. Once more, dog*gone* it, he has forgotten his wife's *wedding anniversary!* And now it is too late—too late! To Kelley, however, nothing like this ever happens, for on that date, once each year, the good old grandfather clock he devised raises a small flag on a miniature flagpole and blows a whistle (*Esquire* please copy). Kelley then dashes downtown and buys flowers.

The design in Figure 2 seems almost ideal. It is a 6" Cassegrainian-Gregorian combination made by Roy E. McAdams, a designer and builder of miniature gasoline engines, according to his letterhead, and situated at 2155 S. Limestone St., Springfield, Ohio. "Time consumed for making patterns, machining castings (which are of aluminum alloy) and grinding and polishing optical surfaces was approximately 8 months' spare time work," he writes.

"The main mirror is 30" in *f.l.* and the Gregorian combination has an amplifying ratio of 6. Despite the fact that its accuracy is excellent, it is used but little." [The present year is the 300th anniversary of James Gregory's birth.—*Ed.*]

"The clock drive consists of synchronous motors and a train of gears which give sidereal time to a minute fraction of a second for a run of 24 hours."

The axes of the McAdams telescope have the cross-section urged by R. W. Porter in "ATM," and the plate attaching the declination axis to the tube is also a thick, heavy one. When mounted on a fixed base this 'scope should be rock-solid. The tube is a piece of engineering design, and the whole is also "easy to look at"—a factor not always combined with good engineering design, just as good engineering design is not always ideally combined with "easy to look at."

The third well-designed telescope is shown in Figure 3 and is commendable for great rigidity. The maker of the mounting, William W. Maxwell, 1018 S. Franklin St., Mt. Pleasant, Mich., whose letterhead indicates that he runs an electric and ox-acetylene welding establishment, has really gone as far as Porter urges in "ATM" (4th ed.) in the direction of that desirable quality—something that few of the telescopes made by amateurs (and professionals) exhibit. This telescope was built as a memorial to the late William Tyler Olcott, for the Daytona Beach Star Gazers' Club, and is to be set up at Daytona Beach, Fla. The piers shown in Figure 3 are merely temporary rough ones of wood. Concrete piers are to be built.

Most of the details are best explained in Figure 4, which is well worth stopping to study at this point. The bearing of the tube is of the full three-point type with really wide spread, and the mounting is as stiff as a mountain.

The counterweight tube, shown in Figure 3, is a piece of galvanized steel bent to form a 20-sided figure.

At the lower end of the polar axis shaft is a 120-tooth starter ring-gear (Figure 5) welded to the edge of the brake drum. The drive is a large hand-cranked phonograph motor and will run for 35 minutes. There are setting circles on both axes and the slow motions operate from the eyepiece neighborhood by way of flexible shafts.

The mirror was made by R. E. Stevens, 500 S. Ridgewood Ave., Daytona Beach, Fla., and is of Pyrex.

"Yours for bigger and better bottlenecks," Maxwell signs his data letter. Proportionately this mounting has the biggest bottleneck we recall seeing, outside of Porter's mounting for the 18" Schmidt at Palomar ("ATMA," p. 398).

Figure 2: McAdams and his solid portable

PEOPLE, themselves, are fully as interesting as telescopes. The following notes attempt to snoop a bit into the private lives of some of the authors of "ATMA," also some amateur telescope makers who seem to have burst right into professional optics.

It has turned out that among the authors of "ATMA" there was an unsuspected moving picture actor. "I presume you know," Capt. M. A. Ainslie of England (himself a capable mirror maker—"ATM," p. 100) tells us, "that the W. T. Hay, F.R.A.S., who writes on a 'Simple Chronograph' in 'ATMA' is better known as Will Hay, the comedian film star." Later, H. E. Dall sent us an English newspaper from which the advertisement shown in Figure 6 is reproduced. He states that a few years ago Hay "was in all the newspapers as discoverer of a

Figure 3: Maxwell's rigid 'scope

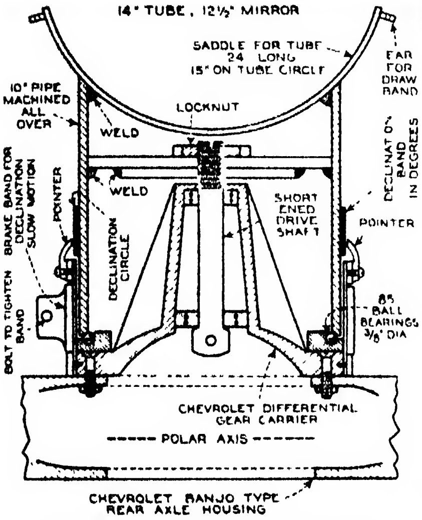


Figure 4: Declination axis detail

new big white spot on Saturn, soon afterward was elected a fellow of the Royal Astronomical Society and then published a book called 'Through My Telescope.'" We find that this same book was reviewed in our June 1936 issue, before we knew Hay's identity. Hay lives at Hendon and owns a 6" refractor.

D. Everett Taylor, author of the chapter on "The Refractor—Metal Parts and Mounting," in "ATMA," before his recent retirement was one of the leading dentists in New York, also an outstanding tenor singer.

H. E. Dall of Luton, Bedfordshire, England, mentioned above (see "ATMA" chap-

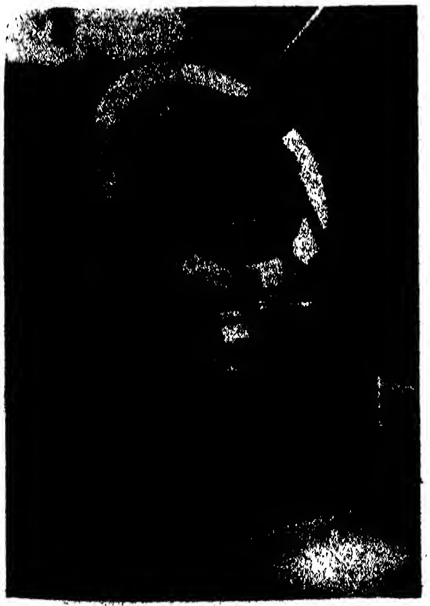


Figure 5: Clock and R. A. circle

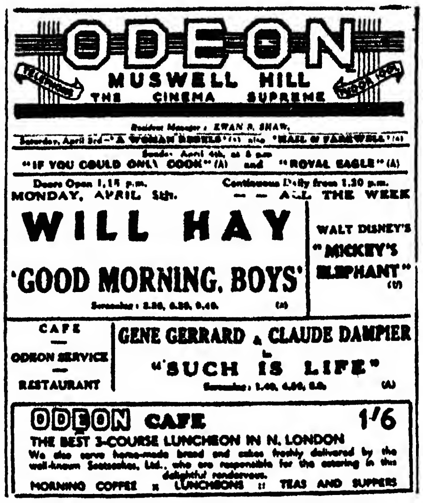

ODEON
MUSWELL HILL
THE CINEMA SUPREME
MONDAY, APRIL 5th. — — ALL THE WEEK
WILL HAY
'GOOD MORNING, BOYS'
WALT DISNEY'S "MICKEY'S ELEPHANT"
CAFE — ODEON SERVICE — RESTAURANT
GENE GERRARD & CLAUDE DAMPIER in "SUCH IS LIFE"
ODEON CAFE 1/6
THE BEST 3-COURSE LUNCHEON IN N. LONDON
MORNING COFFEE :: LUNCHEONS :: TEAS AND SUPPERS

Figure 6: Astronomical cinemactor

ter on the "Camera Obscura") is an engineer who works on design for the 100-year-old firm of George Kent, Ltd., makers of industrial measuring and controlling instruments such as meters for the accurate flow of water, steam, gas, air, oil, and other fluids. The photograph of Dall, Figure 7, was taken by F. W. Epley of the Amateur Telescope Makers of San Francisco, when visiting him in England.

Figure 7: Dall

A. W. Everest (opening chapter, "ATMA," on mirror making) is assistant to the superintendent of the distribution transformer factory of the Pittsfield, Mass., works of the General Electric Company.

Harold (telescope drives) Lower of San Diego, California, with chapters in "ATM" and "ATMA," during the World War was a Leatherneck and instructor on the rifle range and machine-gun school. His hobbies are archery and photography.

Franklin B. Wright, similarly with chapters in both "ATM" and "ATMA," is a telephone engineer with the Pacific Telephone Company.

Cyril G. Wates, "ATMA" page 274, is a maintenance engineer with the Edmonton Municipal Automatic Telephone System, at Edmonton, Alberta, Canada. His hobbies are mountaineering and photography.

John Bunyan ("ATMA," page 425, sidereal clock) is president of the Berthoud National Bank, Berthoud, Colorado.

PERSONALITY items about other prominent telescopticians: No American "opposite" to the English moving-picture actor Hay, named above, is known to us. The closest we can come to this is Rod LaRocque of Hollywood, an amateur telescope maker who now and then does a turn in pictures. Byron, Lord Graves, of Los Angeles, who knows numerous cinemactors and actresses, in reply to your scribe's urging, writes as follows about LaRocque: "Used to be popular in the silent film days. Married Vilma Banky and is a very happy family man. Fine mechanic and has a complete metalworking and woodworking shop (Figure 8) back of his home. Makes ship models, furniture. Built a camera complete, except lenses, which he sold for $250. Built the 6" f/8 shown."

Another American movie actor who rates as a sort of "friend's friend" of telescoptics is Franchot Tone, whose father is president of the Carborundum Company. We doubt whether Franchot actually abrades glass with the paternal Carbo.

In "ATM," on page 402, there is a picture of Winston Juengst, with a telescope. When this was inserted, quite a number of years ago, Juengst was only a young lad; but time marches on and the lad Juengst finally grew to manhood, entered the University of Rochester, took that University's stiff, four-year course in optometry (Columbia also gives a superior course in optometry), and today is teaching in the School of Mechanical Optics, Montague and Henry Streets, Brooklyn, New York, where training is given in the mechanical work of filling oculists' and optometrists' prescriptions.

How many others may have been steered into optics as a life career through the awful effects of "ATM" we know not, but one is W. J. Kiefer, who now has a job in the Bausch and Lomb Precision Optics Depart-

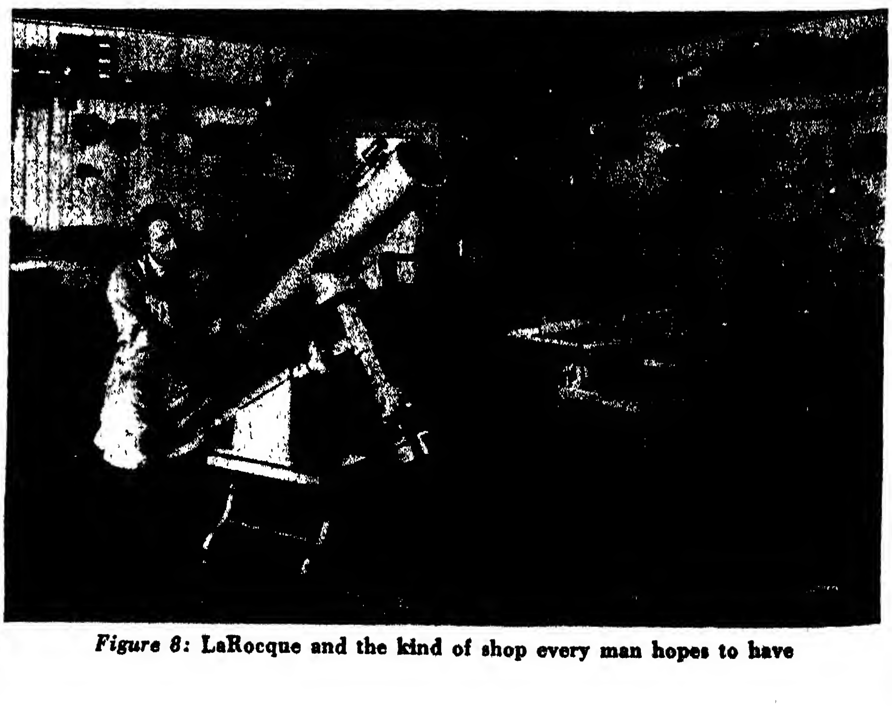


Figure 8: LaRocque and the kind of shop every man hopes to have

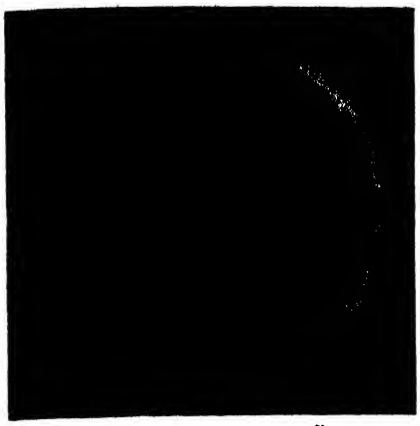


Figure 9: The virgin effort

ment and at present is surfacing various types of precision prisms. R. E. Clark, author of the chapter on eyepiece making in "ATMA," recently told us about Kiefer. "About five years ago," he writes, "we had a young fellow as instructor in our local high school—that is, Kiefer. He made a 6", shown in the focogram (Figure 9) and brought it to me for test and correction. I allowed him the facilities of my basement shop, and during three years I do not think he missed a single night. He then took an A.M. degree in optics at the University of Rochester and went with B. and L."

Urged to give some of the harrowing details about himself, Kiefer first states that the kindness, generosity, and patience Clark exercised in attempting to teach him practical optics are indelibly written on his mind. Regarding his first mirror (Figure 9), he thought at the time that it really was finished, but adds that Clark "evidently didn't." Clark "took one look at it and I guess that was plenty!" He started Kiefer on eyepiece lens making and gave him a course of sprouts all along until he went to Rochester and studied mechanical design of optical instruments, physiological, physical, and geometrical optics. There he also earned part of his tuition by working in the university optical shop assisting H. E. Wilder, optics shop instructor and president of the Amateur Telescope Makers of Rochester who use facilities at Rochester University.

So, if you are just a raw, rank beginner, and are afraid you will never amount to much in the mirror figuring line, look at Figure 9, a first mirror which only a mother could love, and have faith that, in time, and with work, you too will eventually arrive.

Still another average telescope maker was R. W. Dietz, 2187 W. 25 St., Los Angeles, Calif., who is working on a group of Schmidt cameras for the Foundation for Astrophysical Research—that is, as a professional.

Ten years from now, what percentage of U. S. A. optical personnel will be from TNs?

FOR the benefit of new readers of Scientific American, perhaps partly puzzled by some of the more advanced discussions of telescope making and telescoptics which have appeared in this department, a new approach, more elementary, will be made in future numbers by means of special space set aside for the description of simple telescopes such as the tyro can build as his maiden effort, also for discussions having the beginner's point of view. Readers who are already familiar with the amateur telescope making hobby are invited to offer suggestions for interesting the potential tyro.

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Linguists

IT is sometimes stated that patent attorneys have a language of their own. Undoubtedly, the basis for this contention can be found in the fact that in describing new inventions existing words are frequently inadequate and it is necessary to create new words. However, even though the language used in a patent application is strange or unusual it does not affect the validity of the patent as long as the meaning is clear. The patentee may arbitrarily select his nomenclature as long as the meaning of the words is clearly defined. Thus, in a recent patent infringement suit the patent described a part of a sewing machine in the shape of a segment of a circle, as a disk. The Court took the position that while the word "disk" was not aptly definitive of the particular mechanism the meaning was nevertheless clear and on this basis it sustained the patent. In reaching this conclusion the Court stated:

"Of course, I am quite aware that the word 'disk' is a somewhat unusual word to use for referring to a segment of a circle, but anyone can adopt his own nomenclature. Why the patentee adopted the name 'disk' for his ridge-former, shown in the drawing as a segment of a circle, I cannot see, for I think some better descriptive word might have been used."

Liquor Trade Marks

WE have commented from time to time on the growing importance of trade marks. The United States Supreme Court has again emphasized this importance in a recent decision sustaining the constitutionality of a Minnesota statute prohibiting the importation into the State of Minnesota of intoxicating liquors, unless the brand or trade mark was duly registered in the United States Patent Office.

Shortly after the repeal of prohibition the Minnesota legislature passed the statute referred to above. Prior to that time a corporation engaged in the business of selling intoxicating liquors had obtained a license from the State of Minnesota to sell such liquors. Several of the brands of liquors sold by the corporation were not registered in the United States Patent Office, and the corporation brought suit against the Liquor Control Commission of Minnesota to restrain it from interfering with its business, contending that the statute in question violated the 14th Amendment of the United States Constitution.

The United States Supreme Court held that the statute clearly discriminated in favor of liquor produced within the state in that the requirement for federal registration only applied to liquor imported into the state. The Court pointed out that normally such discrimination would be prohibited by the 14th Amendment of the Constitution, but that the 21st Amendment to the Constitution, which repealed prohibition, permitted the state to prohibit or to place any restriction whatsoever on the importation of intoxicating beverages. The 21st Amendment reads in part as follows:

"The transportation or importation into any state, territory, or possession of the United States for delivery or use therein of intoxicating liquors, in violation of the laws thereof, is hereby prohibited."

With regard to this amendment the Supreme Court stated that it confers "upon the state the power to forbid all importations which do not comply with the conditions which it prescribes."

It was accordingly concluded by the Court that the State of Minnesota had the right to prohibit the importation of intoxicating liquors unless the name or brand of the liquor was duly registered in the United States Patent Office.

Lotteries

THE Federal Trade Commission has been active in attempting to restrain the use of lotteries in connection with the sale of merchandise.

In a recent case the Commission found that a manufacturer was supplying retailers with candy assortments designed and intended to be sold by lottery and the manufacturer was ordered to cease and desist from selling candy assortments in which the sales "may be made by means of a lottery."

The proceedings before the Commission were reviewed by a Federal Circuit Court of Appeals and the Court held that the order was too broad since any candy assortment could be sold by lottery. The order was modified so as to restrain the sale of candy assortments in which the sales "were designed to be made by means of a lottery."

Purity

A PATENT cannot be obtained on the purity of a product. This principle is exemplified by a recent case decided by the Court of Customs and Patent Appeals.

An inventor had developed a new process for purifying artificial or synthetic ultramarine. He filed a patent application setting forth his new process and obtained the allowance of claims based upon his process. He also sought to obtain claims for purified ultramarine, contending that it was a new article since prior to the development of his process ultramarine was only obtainable in an impure form. The Patent Office tribunals rejected the claims on the purified ultramarine and the inventor appealed to the Court of Customs and Patent Appeals. The Court sustained the Patent Office tribunals, pointing out that normally it does not amount to invention to provide an article in a purified form when it had previously been available in an impure form. The Court summed up its conclusions as follows:

"We are in agreement with the tribunals below in their holdings that while appellant may be entitled to a patent on a method for purifying an ultramarine either artificial or natural, he is not entitled to a patent on the article which after being produced has a greater degree of purity than the product produced by former methods."

Normally the purification of an article is regarded as a mere change in degree rather than in kind. The Court pointed out that in the rare cases where the purification of an article results in a product having entirely new and unexpected characteristics a patent may be obtained on the purified article. As an example the Court referred to the famous aspirin case involving a patent on the pure form of acetyl salicylic acid. In the aspirin case the pure form of the product was found to have medicinal uses not available from the impure form and the patent was sustained.

Dixie

IN a recent suit for trade-mark infringement the word "Dixie" was held not to be geographical when used in combination with other words as a trade mark for gin. A prominent distiller using the trade marks Dixie-Belle and Dixie Beaux on gin sought an injunction against a competitor who used the trade marks Dixiana and Dixie Dew on gin and whiskey. The competitor contended that the trade marks Dixie-Belle and Dixie Beaux were invalid for the reason that the word "Dixie" is geographical.

The Court rejected this contention and held that the trade-mark registrations were valid and infringed. With reference to the word "Dixie" the Court stated:

"It is not intended to signify that the product is manufactured in the South or intended to be sold or used there nor does it indicate the quality or characteristics of the product."

Title Page

A COPYRIGHT on a book or pamphlet is not valid unless the proper copyright notice is affixed to the title page or to the page following the title page.

In a recent suit for copyright infringement the plaintiff claimed to be the owner of copyrights on two pamphlets. The notice of copyright was affixed to the back cover of both pamphlets. It was contended by the defendant that the notice used on the pamphlets did not comply with the statute and that the copyrights were invalid.

The Court sustained this contention, stating:

"By explicit provision of the statute the place for copyright notice in the case of a book or printed pamphlet is on the title page or the page immediately following. It follows that a notice on any other page, no matter how prominent, is ineffective."

SCIENTIFIC AMERICAN

ADVERTISERS

October · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City
Western Advertising Representatives

EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.

BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 159, No. 4, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • NOVEMBER • 1938

COTTON, picked laboriously by hand for several thousands of years, yields up its fruit to a machine. The particular mechanical cotton picker shown on our cover was developed by The International Harvester Company. It picks much more cotton in an hour than an expert human picker can pick in a full day. Numerous factors, as outlined in the article on page 242, will limit both the time and the extent of its use.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, November, 1938. Vol. No. 159, No. 5, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of November, 1888)

LONG DISTANCE—"Words spoken in Philadelphia can now be heard in Portland, Maine, a distance of 450 miles. . . . The American Telephone and Telegraph Company, of New York, of which President Theo N. Vail and Vice-President and General Manager Ed. J. Hall, Jr., are the energetic and far-seeing executives, is to be congratulated on the successful opening up to telephone service of this vast and wealthy territory. What was at first looked upon as a doubtful venture is now rapidly becoming recognized as one of the successful and progressive moves in recent electrical history."

CABLE RAILWAY—"Cable railways are now being introduced in England. We present herewith an engraving of the engines used for driving the Birmingham cable. . . . The engines have jacketed cylinders 24 in. diameter by 48 in. stroke, and run fifty revolutions per minute; they are fitted with Jefferiss' automatic expansion gear. The piston rods, 4 in. diameter, are of steel: the steam pipes 6 in. diameter, and exhaust pipes 8 in. diameter. A main equilibrium stop valve is placed in a convenient position, so that the engineer can have full view of his engines. Under each fly wheel a powerful steam brake is fixed, so that the engines can be stopped immediately any accident happens to the rope. . . . The rope driving pulleys for the Birmingham service are 10 ft. diameter, in halves, and are also provided with jaw couplings cast on the boss at one side. . . . The carry pulleys along the line are placed 28 ft. apart; the yokes are placed 4 ft. apart; the radius of sharpest curve, namely that at Colmore row, is 45 ft., a very awkward corner; the steepest gradient on the route, 1 in 20, is on Snow Hill."

CONDUIT—"A Pittsburgh man has invented a glass conduit which looks as if it might answer the purpose, and which the inventor is sure solves the problem of underground electric wires."

WESTWARD—"The multiplication of bridges across the great rivers of the West is a movement in the direction of advanced civilization. Simple and cheap pontoon bridges, by their number, may be made to do better work in facilitating intercourse than would be effected by a smaller number of more pretentious structures. For some years their service may be all that will be desired, and, as they prove inadequate, one by one they can be replaced by more permanent works."

VOLAPUK—"The cranks of the age are for the present turning from the congenial labor of inventing perpetual motion machines to invent a new language, which they call 'Volapuk.' It is a conglomeration of all the modern and some of the dead languages, and an experienced linguist can see little sense in it."

DISEASE—"It is reported from Chicago that a by no means inconsiderable local outbreak of scarlatina has been brought about by a cat, which acted as the means of conveying the infection. . . . We are at present only just on the borderland of a wide subject—namely, that of the relationship of diseases of the lower animals to diseases in man; and we may possibly learn hereafter that, apart from the origin of infective diseases in the lower animals, the latter may serve as media for communicating infections to an extent as yet not understood."

MOSQUITO FLEET—"Those who have pinned their faith to big ships, big guns, and heavy armor have had cause, more particularly of late, to doubt the efficacy of the system they espouse. . . . One military journal declares that half a dozen torpedo boats would avail far more in offshore work than the big belted ship which costs as much as a dozen of them."

MYCENAE—"The excavations commenced by Dr. Schliemann at Mycenae are still being energetically carried on, and continue every day to bring to light fresh objects of great archaeological and anthropological interest. Among the numerous objects discovered . . . are articles of glass, crystal, and ivory, besides precious stones with engravings of animals charmingly executed, the whole treatment being Oriental in character."

DAM—"The director of the geological survey is of the opinion that the recently conceived plan of constructing an immense dam across the Rio Grande at or near El Paso is perfectly practicable, but he thinks the question of conflicting water rights must first be settled by the enactment of a general law by Congress. The purpose of the dam would be to irrigate the valley for fifty miles and furnish motive power, to prevent destructive floods, and to settle the Mexican boundary question by keeping the river in its proper channel. It is proposed to make the dam an international affair."

HARBOR DEFENSE—"According to a recent report . . . a large company, backed by millions of dollars, has proposed to the Secretary of the Navy a striking and possibly effective scheme for the defense of harbors from the attacks of an enemy's fleet by shooting ignited petroleum at the unfriendly ships from the bottom of the river and burning them up."

HAMMERS—"The five heaviest hammers in the world were built in the following order: Krupp, at Essen, 1867, 40 tons; Terni works, Italy, 1873, 50 tons; Creusot, France, 1877, 80 tons; Cockerill, Belgium, 1885, 100 tons; and Krupp, Essen, 1886, 150 tons. Thor can take a vacation now."

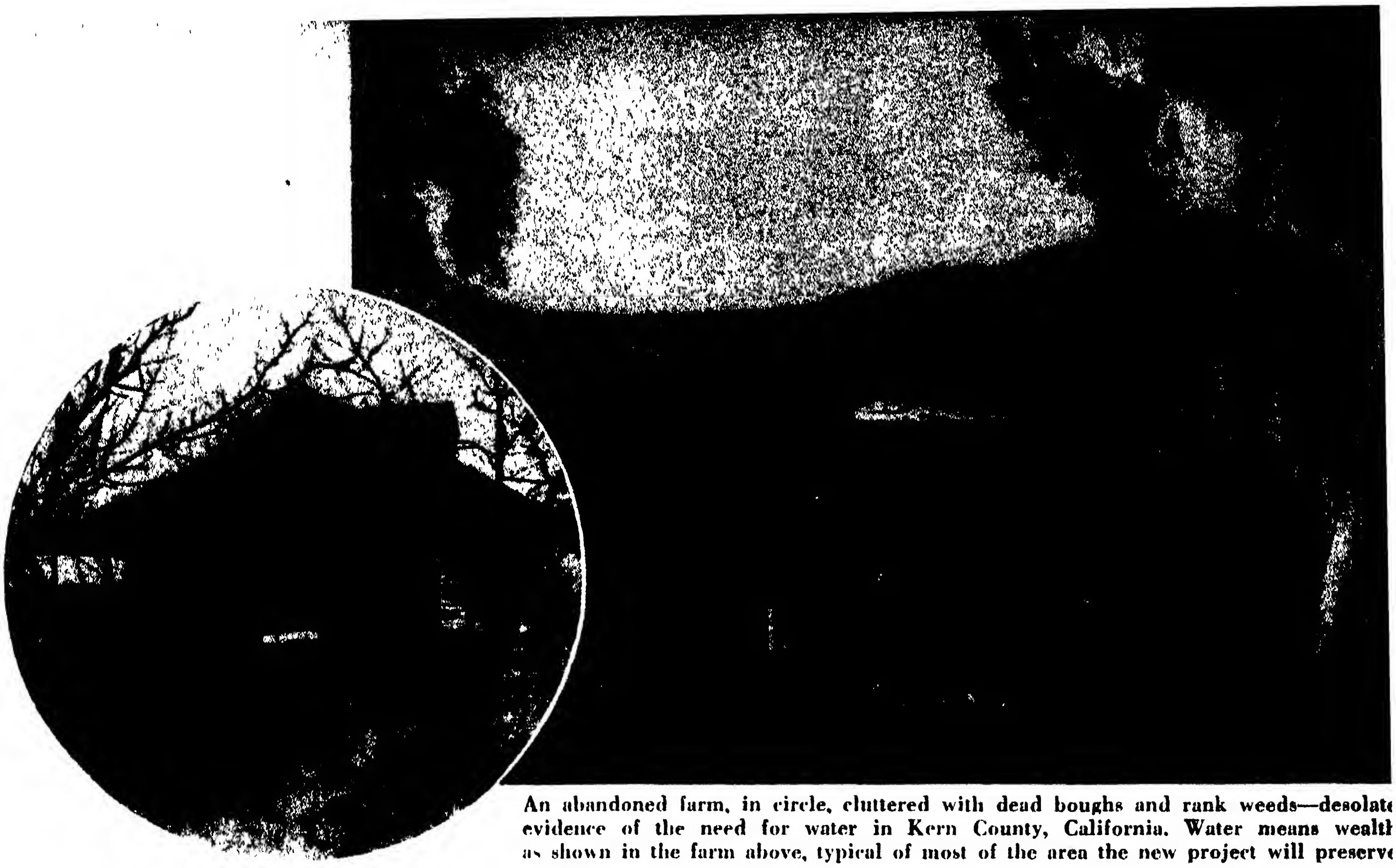
MAINE—"At the Navy Yard, Brooklyn, New York, work has been commenced on the construction of the twin-screw armored turret cruiser Maine, and immense amounts of material and plant have been delivered. This vessel, the largest ever built at the Brooklyn yard, will be of 6,650 tons, and . . . will be 310 ft. long between perpendiculars, 57 ft. beam, 21½ ft. draught, built of steel, with cast steel stem, stern, post and rudder frame."

AND NOW FOR THE FUTURE

- Must human beings grow old? By Barclay Moon Newman.
- Grand Coulee Dam—far larger than originally planned. By R. G. Skerrett.
- Recording the earth's pulse. By Rev. Joseph Lynch, S.J.
- Indian petroglyphs were mere idle scribblings.
- Transmutation cannot be accomplished economically. By E. U. Condon, Ph.D.

SPARKS, STEAM, SPLINTERS

ERRATIC and unpredictable in nature, lightning is gradually giving up its secrets in the laboratory. In the process, bolts of artificial lightning are made to flash over and through electrical equipment to determine the effect and to work out controls for limiting its destructiveness. The flash shown here splintering a telephone pole in the high voltage laboratory of Westinghouse Electric and Manufacturing Company, and sending jets of steam from the splintered cracks, is the quarter millionth such flash that has been made in that laboratory in five years. Dr. P. L. Bellaschi, research engineer, estimates that this number exceeds the frequency of natural lightning "hits" on all the high voltage power systems in the United States during the same period. Each artificial bolt has been made at over 300,000 volts and 65,000 amperes. Five years ago, when the first test was made with lightning in the laboratory, the odds were 99 to one that a direct lightning hit on a distribution transformer would blow it up and cause a serious interruption of service. Today, as a result of this research, the odds are practically inverted.



An abandoned farm, in circle, cluttered with dead boughs and rank weeds—desolate evidence of the need for water in Kern County, California. Water means wealth as shown in the farm above, typical of most of the area the new project will preserve

To Stop Desert Encroachment

Water Table Pumped Lower and Lower, the Desert is Creeping into Rich Central Valley . . . Two Great Dams, Long Canals, Will Supply Needed Water

By **PHIL DICKINSON**
Central Valley Project, Bureau of Reclamation

WHEN Spanish vaqueros first entered the interior valley of California they saw only a vast expanse of desert, broken infrequently by patches of green vegetation along the water courses. Little did they dream that in a span of two generations the region would become one of the world's garden spots, the home of thousands of prosperous families, and the source of millions of tons of food products known around the world. They did not envision the romance and adventure that marked the development of this great inland empire—now a two billion dollar agricultural wonderland built by irrigation and wholly dependent upon a single natural resource—water.

As the Sierra-Nevada range is called the backbone of California, so may the Great Central Valley be considered as the state's living heart. Nature has been kind to the valley by endowing it with soil rich in the elements of plant growth, temperatures conducive to sub-tropical fruit culture the year 'round, and 10 million acres of potential agricultural land surrounded by a mountain watershed of 40,000 square miles.

But Nature has been perverse, too—she neglected to provide proper distribution of her endowments. The water resources of the valley do not conform, either geographically or seasonally, to the irrigable lands. How these resources are to be adjusted by Man is the story of the Central Valley Project, one of the greatest reclamation dramas of modern times. Construction of the project has been started by the United States Bureau of Reclamation.

THE Great Central Valley in the heart of California really is two valleys—the Sacramento and the San Joaquin. The Sacramento River flows down from the north and the San Joaquin River comes from the south. The two, meeting in a common delta, mingle in a myriad of channels, and issue together through the San Francisco Bay system to the Pacific Ocean. The valley is almost 500 miles long from Mount Shasta on the north to the Tehachapi Divide on the south, about 50 miles wide between the Sierra Nevada and the Coast Range, and its floor varies in elevation from sea level to over 400 feet. Prior to the coming of white men it was part desert and part swamp. The first settlers, utilizing the unregulated spring flood flow of the rivers, made it a vast area of grain and cattle ranches. Now, under intensive irrigation, it has become a realm of diversified agriculture, including 83 cities and towns in 20 counties, populated by a million persons.

In the semi-arid climate—characterized by hot rainless summers in which midday temperatures sometimes exceed 100 degrees, mild winters in which frosty nights are the exception rather than the rule, and light seasonal precipitation varying geographically from 5 to 25 inches—choice products of both the temperate zone and sub-tropics are grown. The valley is famous the world over for its raisins, table grapes, and sweet wines. It is acquiring almost equal fame for its phenomenal yield of long-fiber cotton, averaging in excess of 500 pounds of lint per acre compared with a national average of about 155 pounds. Other major crops include fruits and vegetables too

numerous to mention in this discussion.

Adjacent San Francisco and Los Angeles metropolitan areas provide nearby markets for dairy, livestock, and poultry products. Extensive petroleum fields dot the southern valley. Canneries, creameries, wineries, processing plants, lumber mills, and oil refineries operate in many of the cities, on the output of the agricultural, mineral, and forest resources. Gold mining still is important in the romantic Mother Lode counties.

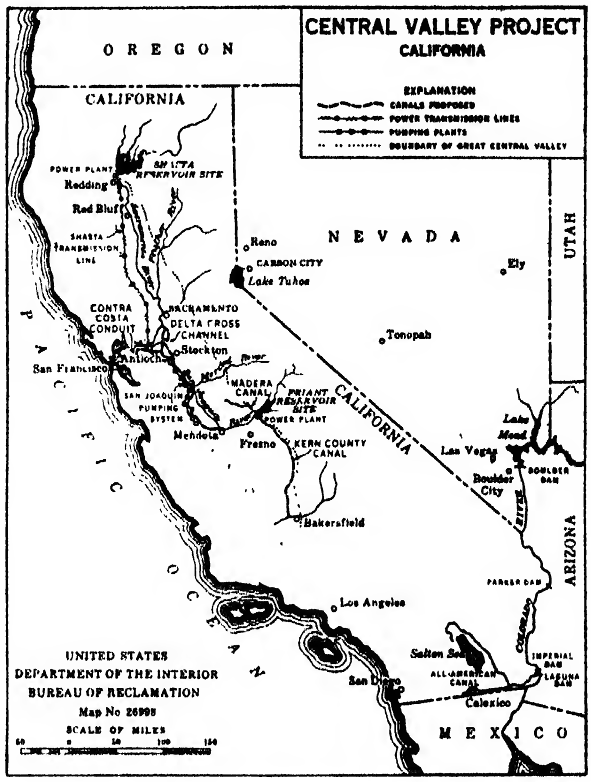
The Great Central Valley's water problem, which has been a subject of study by Federal and State agencies for more than half a century, is mainly a problem of conservation. The unregulated water supply is ample in quantity, averaging more than 30,000,000 acre-feet in the annual flow of the two principal rivers. The Sacramento itself is a mightier stream than the Colorado River. It has a recorded high flood flow of 610,000 second-feet, a peak discharge exceeded only by the Mississippi, Ohio, and Columbia Rivers in the United States.

TWO thirds of the water which Nature supplies in the form of rain and snow falls on the watersheds of the Sacramento Valley which has crop lands with one third of the relative irrigation need; while one third of the water falls to the San Joaquin Valley which has crop lands with two thirds of the irrigation need. That is the geographical problem.

Then there is seasonal waste. In spite of what has been done so far to conserve stream flows, two thirds of the water which Nature deposits annually on these watersheds flows unused to the sea within 90 days after it has fallen. Almost all the precipitation comes in a few months of winter and early spring, and virtually none in the long hot summer and dry autumn when water is needed for irrigation. This condition of climate makes impossible the reasonable use of the water resources without rigorous conservation and economic regulation.

Under existing conditions at least a million acres face an acute irrigation crisis. The extreme low summer flow of the rivers has put an end to upstream commercial navigation, and has permitted the encroachment of salt water from the ocean upon reclaimed crop lands in the fertile Sacramento-San Joaquin delta.

Perhaps the most interesting symptoms of this conservation problem are to be found in the San Joaquin Valley, particularly in the southern portion, where about 400,000 acres of settled and producing lands now are dangerously short of water. Spring floods this year in California served only to focus new attention on the problem, for by August the streams had faded to a trickle. Almost all the normal surface flow in this region years ago was fully appropriated for irrigation, and the farmers resorted to pumping water from underground in the summer and fall. As this type of irrigation increased, ground water levels fell; and the farmers discovered, years too late, that their draft upon the subterranean supply is greater than its annual natural replenishment by rainfall and stream flow.



In one area, the water table 20 years ago stood 10 to 20 feet below the surface. Now it is down as far as 240 feet, requiring a pumping lift, considering draw-down in the wells, of as much as 275 feet. The cost of such pumping of water in volume required for irrigation in many cases has made the continuance of crop farming economically impossible. In another area, the pumping depths vary from a minimum of 100 feet to a maximum of 275 feet; in the Ducor citrus groves, from 200 to 250 feet; around Exeter, 100 to 175 feet; and McFarland, 90 to 250 feet.

The extraction of ground water for the lands now developed greatly exceeds that which percolates into this underground reservoir. Studies show that under the 400,000 acres on which the water table generally is falling in Tulare, Kern, and Fresno Counties, there is an annual water supply sufficient for only half that acreage. Thus, the conclusion is unavoidable that 200,000 or more acres of highly developed lands will have to be abandoned unless relief is forthcoming. As a matter of tragic fact, the latest survey shows that between 40,000 and 50,000 acres already have gone—more than double the abandoned acreage of six years ago. Unfortunately, it is the best 200,000 acres that are succumbing first—those in the citrus belt in the frost-free foothill coves that produce crops worth $20,000,000 annually. The situation is similar, though less acute, in Madera County in the northern San Joaquin Valley.

In the face of these conditions, a pertinent question is: what is being done about it? The answer is to be found in a description of the Central Valley Project, a multiple-purpose reclamation undertaking of the Federal Government. To conserve and regulate the Valley's precious water resources, the Bureau of Reclamation is engaged in a $170,000,000 program which involves construction of large storage dams on the headwaters of the two principal rivers, and the building of a 350-mile system of main canals to serve areas of water deficiency.

The key to this approved solution of the valley's water problem is, of course, the mighty Sacramento River with its surplus water. A contract has been awarded to a syndicate of 12 large contracting firms for the construction of giant Shasta Dam on the upper Sacramento River north of Redding, in Shasta County. It will be the second largest con-

Water table in this deep well formerly was 10 to 20 feet below the surface; now 240 feet down

crete dam in the world, rising about 560 feet from the lowest foundation to the top, slightly higher than the Washington Monument. Shasta Dam will be a curved gravity-type structure, 3500 feet long on the crest, and 580 feet thick at the base, requiring 5,600,000 cubic yards of concrete in its construction.

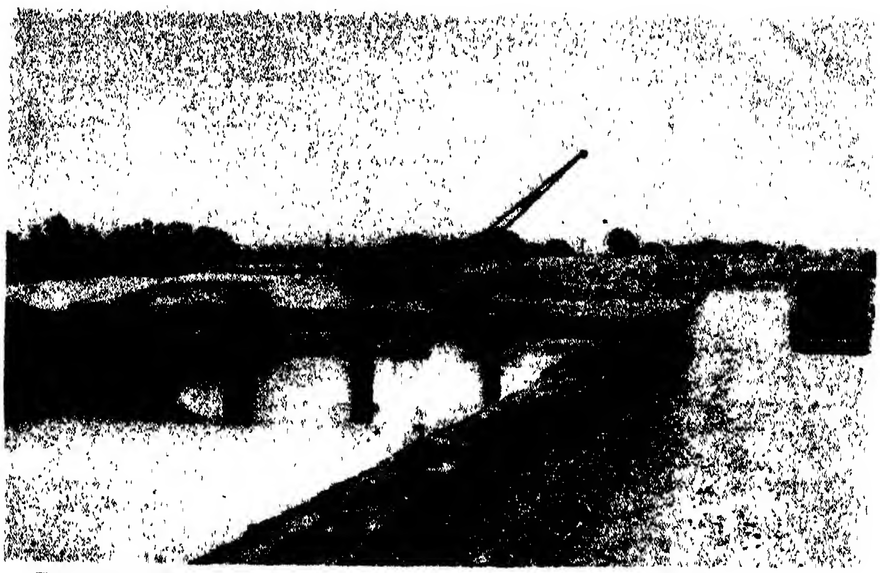
Second only to Boulder Dam in height, and exceeded only by Grand Coulee Dam in mass, Shasta will be first in at least one respect: it will be the highest overflow type of dam in the world. Water falling over the 375-foot spillway in the center of Shasta Dam will have a drop of 480 feet, three times the height of Niagara Falls. River outlets will be provided through the dam at three elevations. A hydro-electric plant at the base of the dam on the west bank of the river will accommodate five main power units, each to consist of a 70,000-kilowatt generator driven by a 100,000-horsepower turbine.

The existing Southern Pacific Railroad winds up the Sacramento River Canyon past Shasta Dam site. Thirty seven miles of this line are to be replaced by 30 miles of new line over the mountains at an elevation above the high-water level of the future reservoir. During construction, trains will pass through a diversion tunnel.

With a tributary drainage area of 6665 square miles, Shasta Dam will back up the waters of three rivers—the Sacramento, Pit, and McCloud—a distance of about 35 miles each, to create a reservoir with a gross storage capacity of 4,500,000 acre-feet. This is water enough to cover the entire city of San Francisco to a depth of 167 feet.

THE reservoir will be operated to diminish the flow of the Sacramento River in flood times and increase it during the dry months—in substance, to stabilize the year-'round flow. It will, thereby, check seasonal waste of water to the sea, permit restoration of all-year navigation on the river as far north as Red Bluff, afford improved irrigation in much of the Sacramento Valley, repel seasonal intrusion of salt water in the channels of the Sacramento-San Joaquin delta, and incidentally generate about 1,500,000,000 kilowatt-hours of electricity annually for municipal, industrial, agricultural, and project use. Finally, when the conserved waters of the Sacramento River have performed all of these functions, and have passed every possible user on that river, they will afford a surplus for export by canal from the delta to parts of Contra Costa County and the San Joaquin Valley.

Through the network of 550 miles of channels and sloughs which comprise the delta, a Cross Channel will be constructed at the eastern edge to facilitate the fresh-water flushing of the sometimes-salty waterways, and to introduce surplus Sacramento River water to the intakes of the Contra Costa Canal and the San Joaquin Pumping System.



First part of the Central Valley Project to be constructed is this initial four-mile section of the great Contra Costa Canal, which will be 46 miles long

The Contra Costa Canal, scene of first project construction in October, 1937, will take 350 second-feet of water from Rock Slough of the San Joaquin River near Knightsen. Four pumping plants will lift it to an elevation of 124 feet whence it will flow by gravity. The canal, 46 miles long, will afford a dependable supply of fresh water for industrial use in manufacturing and processing plants along the south shore of Suisun Bay, for domestic use in several Contra Costa County municipalities, and for agricultural use in an upland area of orchards and field crops. It will terminate in a small reservoir near Martinez.

The San Joaquin Pumping System will comprise a series of works to lift water from the delta up the San Joaquin Valley about 100 miles as far as Mendota. The object is to furnish substitute water from the delta to lands in the northerly half of the San Joaquin Valley now irrigated by San Joaquin River water which is to be conserved and diverted at Friant Dam. The essence of the plan is a neat exchange.

Friant Dam, on the upper San Joaquin River near Fresno, will be a sizeable structure itself. Although only about half as high as Shasta—285 feet compared with Shasta's 560—it will be almost as long—3300 feet against Shasta's 3500. Friant Dam will be a straight gravity-section concrete dam with an overflow spillway in the river section, outlet conduits through the dam for river regulation, and similar outlets to the Friant-Kern and Madera Canals which will divert at the dam.

To the people in the rich agricultural counties of the southern San Joaquin Valley whose very existence depends upon an adequate supply of water for irrigation, the most important features of the Central Valley Project will be these two large gravity canals leading from Friant, one southerly an ultimate distance of 160 miles to the Kern River west of Bakersfield, and the other northerly 40 miles to the Chowchilla River above Madera.

The Friant-Kern Canal in popular conception will be a "young river"—68 feet wide at the water surface and 15 feet deep in its upper reaches. This concrete-lined channel, 30 feet wide at the bottom, will have a capacity of 3500 second-feet for the first 30 miles, decreasing in size thereafter in accordance with the amounts of water to be taken out at various delivery points. The Madera Canal, with a diversion capacity of 1000 second-feet, will be 32 feet wide at the water surface, 10 feet wide at the bottom, and will carry water nine feet deep. These two canals will deliver supplemental water to parts of Fresno, Madera, Tulare, Kings, and Kern counties where the failure of the existing supply, mostly from underground, is threatening the reversion to desert of large acreages of once-lush crop lands.

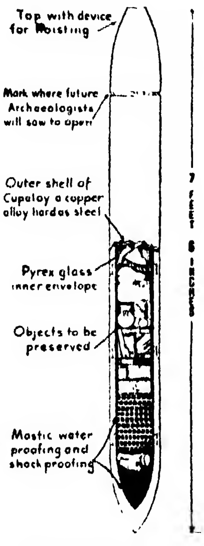
Construction of the Central Valley Project, involving besides the dams and canals many auxiliary features such as bridges, tunnels, inverted siphons, and similar structures, is of tremendous importance to California. The project is to be self-liquidating under the reclamation laws, with revenues to be derived from the sale of the project's two facilities, water and power. Present interest is concentrated upon the imminent construction era with its immediate benefits of large-scale employment and heavy expenditures in many states for materials and supplies. Of far greater significance, however, will be the more lasting benefits of water conservation for improved navigation, flood control, irrigation, salinity repulsion, and electric power generation, which will follow completion of this great Federal reclamation enterprise.

A LEGACY FOR 6939 A. D.

Buried Metal Capsule Contains Sample of Our Civilization . . . Some of Our Products . . . Millions of Words in Print . . . For Future Archeologists

By DAVID S. YOUNGHOLM
Vice-President, Westinghouse Electric and Manufacturing Company

AT the bottom of its 50-foot "Immortal Well," beneath the rising walls of the Westinghouse building at the New York World's Fair 1939, the world's first Time Capsule has begun its long journey into the future—a journey which, it is hoped, will extend through 5000 years of time and give future archeologists a considerable insight into our present civilization. Unlike H. G. Wells' imaginary apparatus, however, it cannot hasten forward through Time; it can only wait.



Drawing of The Time Capsule

The Time Capsule represents months of careful planning and the combined efforts of hundreds of persons. Archeologists, historians, scientists, engineers, librarians, scholars, and many others were consulted at every step, so that the project might be as nearly successful as all our present-day arts and sciences could make it.

Leaving a message from our time to so distant a future presented three distinct problems: How to build a vessel capable of preserving the record; the selection and preservation of the objects to be included; and how to leave word of its whereabouts for future historians.

The Capsule, as finally constructed, consists of an outer shell of Cupaloy (chosen because of its electrical qualities and resistance to corrosion), cast in sections, each section to be threaded and screwed into the next and sealed with asphalt.

The contents of the torpedo-shaped capsule were packed securely in an inner envelope of Pyrex glass, which was then sealed, evacuated, filled with nitrogen, and set into the shell in waterproof mastic. The inner crypt is about six and a half inches in diameter and seven feet long.

More than 40 articles of common use are included. Among them are a fountain pen and mechanical pencil, a watch, an electric lamp, a tobacco pouch with zipper, tobacco, pipe, cigarettes, cosmetics, a woman's hat, eyeglasses, toothbrush and powder, a miniature camera and film, a razor, a can opener, specimens of our money, and so on. There are samples of the major metals and alloys; textiles, including wool, cotton, silk, linen, rayon, glass fabrics, rubber fabrics, asbestos cloth; materials such as Portland cement, asbestos, synthetic and natural rubber, synthetic plastics; also samples of coal (which may be rare in 5000 years), seeds of staple food crops, and many other items.

Most important is a carefully prepared microfilm "essay" on our times, taken from books,* almanacs, pictures, arranged in logical order to cover all the major activities of human life. Multi-lingual texts, a dictionary, and an idiomatic lexicon will enable future historians readily to translate the texts of the microfilm. All film in the Capsule is cellulose acetate for permanence. The microfilm contains a total of more than 23,000 ordinary book pages, reproducing more than 10,000,000 words, and many hundreds of pictures. A microscope is enclosed to enable "futurians" to read the text. Complete directions in text and picture are given for the construction of a larger reading machine and a motion picture projection machine.

For use with the latter, a newsreel is enclosed, specially prepared for the people of A.D. 6939. This contains nearly a score of historic, typical, or significant scenes of our day, with sound.

Word will be left for future archeologists in the form of a Book of Record, printed with specially compounded permanent inks, on 100 percent rag permanent book paper. Copies will be sent to libraries, museums, and other repositories throughout the world with the expectation that some will survive, either in the original form or translated into new languages that arise.

In order that futurians may know when the year 6939 has come, the equivalent of this date is given in the book not only in our own calendar, but also in the Chinese, Jewish, Mohammedan, and Shinto. If none of these survives, futurians may still calculate the years elapsed by reckoning from astronomical data supplied by the United States Naval Observatory. These include the number and dates of eclipses of the Sun and Moon in 1939, the positions of the planets, and the angle of the Earth's pole relative to the star Polaris.

*The complete September, 1938, Scientific American is reproduced in this microfilm.

The United States Coast and Geodetic Survey has provided a description of the Survey's network of stations across the United States, astronomical and geodetic locations of nearby permanent stations, and the exact latitude and longitude of the Time Capsule, determined by a special survey. Given to the third decimal point in seconds, these geodetic coordinates are sufficiently accurate to locate the spot with an error of less than an inch. They are: Latitude 40° 44′ 34″.089 North of the Equator; Longitude 73° 50′ 43″.842 West of Greenwich.

IF other guides fail, the futurians can still find the Capsule. Minute directions have been prepared for constructing and using electro-magnetic instruments to locate it by the methods widely used today.

Finally, that our language may not be lost, the book contains a simple but ingenious Key to English which will permit readers to translate our tongue and to pronounce it, 1938 style, as well.

It is impossible, of course, to detail here all the studies and reasoning which led to the construction of the Time Capsule and selection of its contents. We have undertaken with humility the enormous task of leaving this message to the future, realizing well that no selection of ideas and materials, no matter how large, could really do justice to the astonishing variety and vigor of our age. Whether, in the end, the project can achieve its purpose still depends on ourselves and our posterity—that the Book of Record may be preserved and the Time Capsule left undisturbed. The engineering difficulties of removing it from its resting place in 50 feet of muck can probably be counted upon to protect the Capsule from vandalism. We feel that the good instincts of the human race may be relied upon to preserve word of its whereabouts for the generation to whom it is addressed.

OUR POINT OF VIEW

Arid Farming and Ecology

NOW that the semi-arid and arid states, the latter including the recently famous but already half-forgotten Dust Bowl, have produced good crops for two successive seasons, another kind of drought, a "drought" of human foresight, appears likely as in the past to set in about on schedule time and hold sway until we reach the next period of poor rainfall. Hardly, however, can we expect to settle a great problem by concentrating on it only when it is definitely upon us. Some of us, therefore, must study the problem on an all-time basis and, by much continued harping on the findings, gradually hope to raise public awareness of the answers to such a level that intelligent results will be attained at a later date.

The drought of 1936 has been closely studied by the United States Geological Survey, one of Washington's efficient bureaus of many years' standing, and the question of drought in relation to climate discussed in available documents. From such study certain "frozen facts" are quite evident, though the answer—the final remedy—is not of the kind one instinctively seeks; that is, it is not any simple, direct, short or especially tangible cure-all. Rather it is a recommendation for closer application to details—something not easy to bring about.

One of the most pernicious phases of the arid states' drought difficulty is man's cussedness to man—"man against himself." With the coming of drought, thousands of discouraged farmers pull up stakes and depart hence. A few years later, with the return of the rains, the first to bring in a "bumper crop" is the booster and the boomer—bumper crops of the victims of over-optimistic misrepresentation, people whose lack of scientific background makes it easy to convince them that droughts are not periodic but accidental and that the final one is past and gone forever. Against such misadventure the people must be educated—no simple task.

As its final answer to the drought problem the Survey offers the study of the science of *ecology* by more of the people than understand it now. "More people must come to understand human ecology, plant ecology, and animal ecology."

How many of the plain people today understand the science of ecology? How many can define it? How many have ever heard the word? And how many, on learning what ecology is, will get down to close grips with its underlying principles and sense what a pregnant science it is? For ecology is not a science that is self-evident at first glance. It grows on its student only as it is studied. Simply defined but most inadequately set forth by any mere attempt at definition, ecology is the scientific study of the relations between plants and animals (man included) and their environment. If this study is the prerequisite to the farmer's success with the arid regions, we have a long road to travel, for the study is relatively a new one even among scientists. And the sooner begun the sooner ended.—*A. G. I.*

Too Old at Forty?

FORTY years old and on the shelf! That is the plaint raised so often by persons who, seemingly, have just discovered that when a man reaches the age of 40, he finds it extremely difficult to get a job. That is quite correct, but discussions of the problem usually give the impression that a man at 40 is shelved entirely, that those who have jobs are automatically dropped from the payrolls soon after reaching that age. The facts show that the reverse is true. All these years of argument, however, did not bring out the figures and it remained for A. W. Robertson, chairman of the board of Westinghouse Electric, to do so.

Taking his own company as an example, Mr. Robertson shows that its payroll has a higher percentage of persons over 45 than has the general population. Thirty-one percent of those employed by the company are over 45, while persons of this age constitute only about 23 percent of the entire population. This comparison of percentages will hold throughout most manufacturing organizations. "After all," Mr. Robertson reminds us, "older men rule the world. It isn't reasonable to assume that they are leagued against people of their own age. One thing of which we may be certain is that industry is not hostile to the older man. He is usually more steady, more careful and reliable, and is generally an entirely desirable type of employee."

Now that these facts have been pointed out, memory calls to mind hundreds of inspection trips through many plants, large and small, and sight of a high percentage of relatively ancient workers of both sexes. And about them there was always an air of contentment, a sense of responsibility, a pride in good workmanship, a spirit of service. Why? Perhaps these older ones retain some of the idealism of youth. Perhaps they realize how necessary is their work, how much the product of their brains, their hands, their experience contributes to the well-being of the nation as a whole. It may even be because they are of a generation that still believes in the joy of working, that does not expect something for nothing.

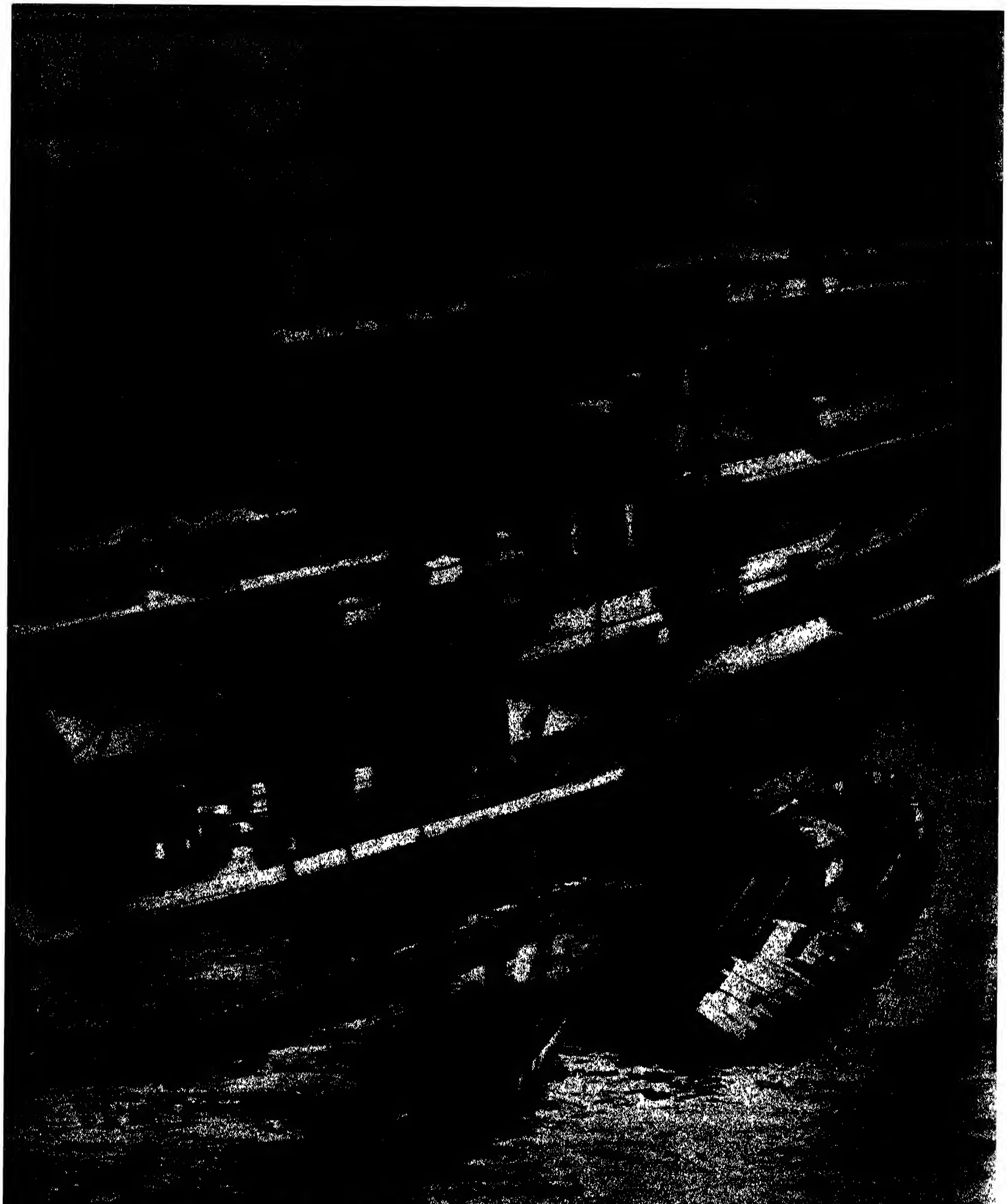
That older men are employed in manufacturing does not, however, make less serious the problem of unemployment. Millions still are looking for work. When they get it, as they assuredly will, let us hope that they will go into their new jobs with some of the spirit of these mature workers on whom so much depends, and work with a singleness of purpose toward the day when they, too, can look backward with contentment and pride on years of gathering experience and rendering service.—*F. D. M.*

It Can Be Done

DURING the first seven months of 1938 there was a decrease of 22 percent in highway deaths throughout the United States, compared with the similar period in 1937, and this with an increase in traffic volume of 1 percent. So reports the National Safety Council. Here indeed is good news.

Part of the increase in highway safety undoubtedly can be attributed to safer highways, better law enforcement, improved road-sign systems, and so on. But it can hardly be questioned that by far the greatest portion of the record must be credited to "education" and its cumulative effect on motor-car drivers. Educational campaigns conducted by a wide variety of organizations through the media of the press, the radio, bill-boards, and almost every other conceivable channel that ultimately reaches the brain of the driver, have begun to show results. Just when the situation seemed darkest, when many were ready to throw up their hands and admit that a solution of the serious problem could not be found, statistics carefully compiled show a gleam of light. Drivers can be educated to safety; so educated, they will drive more carefully; so driving, they will have fewer fatal accidents.

A start has been made, a theory proved. If fatal accidents can be reduced by 22 percent, they can be reduced by 44 percent, by 66 percent, by even more. Such reductions can be made, however, only by keeping everlastingly at the process of driver education. Those who have contributed to the cause must not rest on their laurels. They must continue to strive toward the irreducible minimum of accidents that is the ultimate goal.—*A. P. P.*



The Italian Navy at a Glance

TO an American layman, several unusually interesting details are brought out in this drawing by Dr. Oscar Parkes, the second of a series which we shall publish this year through arrangement with *The Illustrated London News*. The most immediately apparent is possession by Italy of five monitors, a type which Americans associate with the earliest days of ironclads. The illustrated *Faa di Bruno* is said to have given a good account of herself, with her two 15-inch guns, during the World War. Note the incongruous peaked roof forward. A second noteworthy point is the splendid group of 12 destroyer

leaders apparently already built and the 12 large leaders that are to be built. Needing this type for many years, the United States did not start building leaders until the last two or three years. The Italians have evidently proved the success of small motor torpedo boats, for it will be noted that they have 100 large and 24 small ones. Our own Navy long denied that these small craft could be useful to us but lately there has been talk about experimenting with the type. A fourth important fact, emphasizing Italy's confidence in land airplane bases and her evident belief that any war she will fight will be in restricted waters, is that she possesses only one seaplane carrier and no flight-deck carriers. It will be noted also that Italy has a powerful underwater fleet with 106 large and small submarines and a large number of ocean-going ones to be built.

ELECTRICAL RHYTHMS

What Causes Our Brain Waves and What Do They Signify? . . . Hypotheses . . . Have They Something to Do With Vision? . . . A Beginning Has Been Made

(In Two Parts—Part Two)

THOUGH records of electrical brain waves from the same head vary, they are fairly distinctive. Often they may be picked out of a gallery of miscellaneous rhythms. So an individual may frequently be recognized by his brain waves. It is not true, however, that brain waves have the individuality of fingerprints—despite popular press reports. The wave-patterns of a given person merely tend toward similarity in the long run.

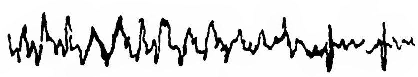
Wave-patterns do not hint of sex. Without previous familiarity with a given record, the scientist cannot decide: "This pattern is from a fair head," or "That pattern is from a thick-head, a man." Still, it is claimed that women are likely to show about 11 waves per second, and men, about ten.

Twins have fascinatingly similar Berger rhythms. This is but another evidence of the close bonds of twinhood. In addition, it is a clue for investigators who are trying to determine how fundamental a phenomenon the alpha waves are. Were rhythms of the average pair of twins not alike, brain probers would have doubts concerning the importance of brain waves.

Does the Berger rhythm in any way indicate level of intelligence? No—except perhaps in a very indefinite and roundabout way.

In schizophrenia, the alpha waves are said to be superimposed on larger waves of lower frequency, called "delta waves," as shown above. The analysis of the record is done graphically or else by means of an automatic electrical device

The unmistakable cusp-and-dart pattern of petit mal seizures in epilepsy. This pattern is visible sometimes in sleep when the other symptoms of the seizure are absent



Grand mal in epilepsy has a pattern basically similar to that of petit mal, but the violence of the seizure introduces other currents which may complicate the tracing

THUS far, the Berger rhythm of the adult brain alone has been considered. Very young infants are said not to manifest the waves. Observation is that no rhythm appears until after the age of three months. Somewhere between the age of three and six months the waves show up. At seven months, their frequency is about four and a half waves per second. At 13 months, the waves come at the rate of about six per second. Adult frequency is not reached until approximately the age of 12 years.

What is the explanation of this delayed appearance and gradual increase in frequency of brain waves? Briefly, everyone is mystified. Some theorists would have it that the onset of the rhythm is correlated with the development of the brain center controlling vision.

In support of this contention, it is said that, as a rule, the infant at about the age of three months starts to take note of objects and to follow them with its eyes. Theorizing, Lindsley continues:

"We believe that the onset of the alpha waves at about this time may indicate some relationship with this functional ability," and may further indicate "the onset of function in the particular brain area investigated"—the visual center, where vision is controlled.

The experimental evidence, however, consists almost solely of the Berger rhythm determinations at various ages. With respect to a delayed onset of function in the visual region, very little is really known. Stage of development of intellect may also conceivably be a factor here.

What of distorted mentalities and the Berger rhythm? Observer Lemere believes that individual differences in the rhythm are highly significant:

"The ability to produce 'good' [strong] alpha waves seems to be a neuro-physiological characteristic which is related in some way to the affective [emotional] capacity of the individual."

In Lemere's hypothesis, a person tending to have marked "up" and "down" states—that is, a person alternately highly elated and deeply depressed—should produce "good" waves. An individual with a schizoid personality—that is, an individual who may be said to project his dreams excessively into his daily activities—on the other hand should give "poor" waves.

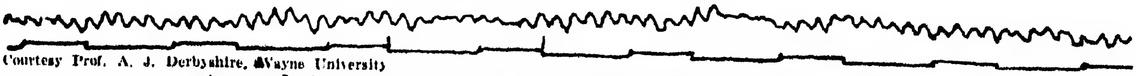
Having developed this hypothesis out of his studies of fairly normal persons, Lemere turned to psychotic patients to verify it. According to his observations, schizophrenic patients do indeed always have "poor" rhythms, while manic-depressives give "good" rhythms — the schizophrenic being the extreme schizoid, and the manic-depressive the extreme in ups and downs.

An impartial scientific opinion, however, warns concerning Lemere's speculations:

"We must still regard any such suggestions as tentative working hypotheses. There seem to be too many exceptions."

Yet it is widely accepted that rhythms of twisted personalities will eventually be found to differ significantly from rhythms of normal people. So far, no agreement has been attained as to what significant differences are likely to be clearly demonstrated. Certain labors are toward the invention of refinements of Lemere's methods and toward the determination of what shades of meaning are to be allotted to exceedingly minor variations in rhythm. At any rate, working hypotheses such as that of Lemere are, though tentative, still new leads to the awesome problem of insanity. In fact, it is already being suggested that, should a person begin to have symptoms of serious mental unrest, a study of his electro-encephalogram is in order. What definite outcome this study would have, and even how the study ought to be conducted, are moot points.

The present cash value of such leads cannot even be guessed. Too much is rumored about what startling treasures science is going to dig up—some fine day. But if there are any doubts regard-



Courtesy Prof. A. J. Derbyshire, Wayne University

A record of a normal subject, showing alpha waves of a characteristic type

OF THE HUMAN BRAIN

By BARCLAY MOON NEWMAN

An electro-encephalograph of the five-channel type, similar to the three-channel apparatus shown in the first installment of the article but having greater possibilities. The physician is reading the ink-written oscillogram

Courtesy Electro Medical Laboratory, Inc.

ing Berger's deserving a Nobel award — always based on profit already on the balance sheet of science—they melt away in the light which is today brilliantly cast upon the timeless affliction, epilepsy. The electro-encephalograms of epileptic seizure have provided the first new experimental evidence in many years as to the nature and possible causes of this mighty medical bafflement, the mightier because the disease is incomprehensibly linked with heredity.

Now we know that in an epileptic seizure, the hitherto blithe little wavelets surge into menacing, high-voltage billows which ultimately seem to involve all the cells of the cortex. It is as though an electric storm accompanied the mysterious gales which lash the brain and force the body into writhing upset.

As the tape slides past the observer's eye, the oncreep of the storm can be clearly seen. The waves become slower, and gradually beat more and more powerfully, as more and more regions of gray matter are stirred up and made to volley electricity. Thus, large slow waves come to stand out on the tape.

The voltage triples, as estimated by the height of the waves. The beat falls to three waves, or perhaps only one, per second. And as the pen moves up to mark each crest, in unison with the brain discharge, it makes a curious down-twitch—small, but observably splitting the smooth contour of each wave. This down-twitch signifies an odd and sudden slight drop in voltage. The last spasm brings the calm of unconsciousness, as the simultaneous electric beat of many million nerve cells breaks up and is gone.

NOW medical scientists know that the climax thus built up represents a definite over-excitation of the highest centers of the brain—the centers located in the cortex. Moreover, severe epileptic attacks are distinctly seen to involve practically the whole brain-surface.

Petit mal epilepsy is characterized by milder symptoms, but the wave records of attacks are very much like those of grand mal, the severer form. Hence it is already to a certain extent possible to accomplish what has never before been possible: to predict the onset of a seizure. One need only remark the diminishing frequency and increasing height of the alpha waves.

Gratifyingly enough, it has further been possible to detect a condition approaching that of true epilepsy. Certain individuals of disturbed mentality and recurrent emotional lapses have been shown to exhibit rhythms characteristic of epilepsy. The conclusion is that extremely mild and therefore unsuspected epileptic afflictions are to be found, probably much more often than has been thought. Consequently, the outlook for Berger's hypothetical new leads to enigmas of distorted mentalities, including the insanities, begins to promise more.

Since both mild and severe seizures can be scientifically investigated and electric aspects recorded, the influence of various factors, such as drugs, food, blood-oxygen, amount of sleep, can be measured to an instructive degree. The delight of the long-puzzled expert on epilepsy can scarcely be imagined.

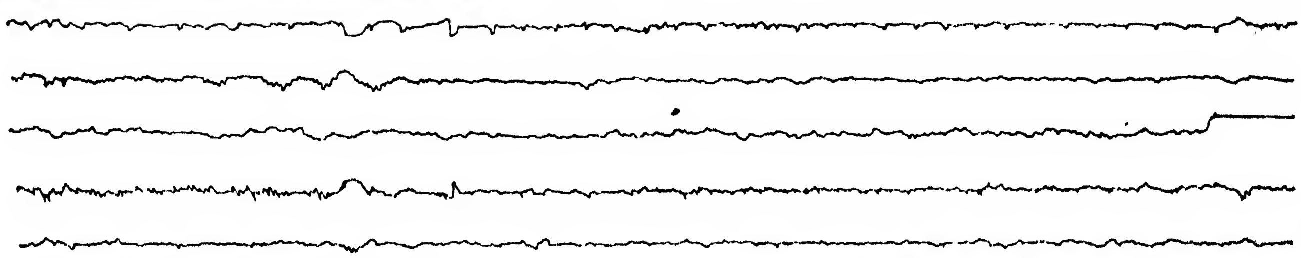
How do we know that the cortex—the surface layer of the brain—is really the source of alpha waves? There are sources of electrical rhythms outside the skull: muscle contraction, the pulse, and respiration always give rise to observable electrical changes, many of which are rhythmic. Wrinkling the forehead by contracting the scalp muscles produces recordable electric oscillations. A tense muscle quivers electrically, rhythmically. Graphs of the electrical rhythm of the heart have for years been used in the diagnosis of cardiac conditions, as well as in the study of the normal heart.

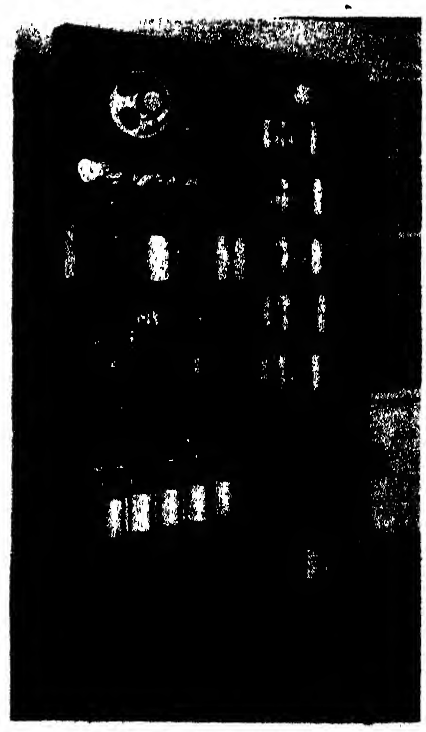
To demonstrate that the Berger rhythm originates in the cortex, these possible extra-brain sources must be eliminated first. So records were taken simultaneously of alpha rhythm, and of electrical variations caused by the pulse, by respiration, and by any chance muscular contraction. The individual and independent existence of each type of pulsation was by this means clearly recorded.

A patient with paralyzed scalp-muscles turned up, and Adrian and his co-worker, Yamagiwa, obtained alpha imprints as distinct as when scalp muscles are functioning. And these two experimenters went on to insert a metal disk into the cortex of a cadaver, plastered up the cracks in the skull, and bandaged elec-

Brain wave record of a mongolian idiot, taken with a clinical electro-encephalograph

At left: Electro-encephalograph of the five-channel type faced by its motor-driven continuous camera which records the oscillograms photographically, and, *lower right,* the back of the same apparatus. The five lines of records between the two photographs were made simultaneously on a five-channel electro-encephalograph. Note the differences in the waves. Each is led or taken off from a different region on the same subject's cranium





trodes against the scalp. Then they set up electric oscillations in the disk, using a frequency and a voltage approximately the same as those presented by alpha oscillations. Not only were these electric pulses detectable on the scalp, but even were led off to trace out inky trails very like those of the real Berger rhythm.

Needle electrodes stuck into the brain of a cat convey signs of the alpha rhythm until the points pierce a slight distance below the cortex. Pushed deeper, the needles send back no rhythm. Return their points to the surface of the brain, and the rhythm is retrieved again. The source of the alpha waves is not above or below the cortex. It must be in the cortex.

Yet the cortex is a broad expanse, with fascinatingly diverse regions. Where in particular in this brain jacket do the alpha waves arise? The marked effects of light point to the visual centers at the back of the brain. And contacts variously placed on the scalp usually yield the strongest waves when located over the visual region. Hence the optical centers are regarded as the prime source of the electric pulse named alpha.

BUT the focus of the alpha rhythm may swing outside the area of visual control and have play farther forward, on one side of the head or on both. Sometimes, however, the waves drawn off from one hemisphere differ in frequency and form from those drawn off from the other hemisphere—and no one understands why.

The evidence is, too, that the rhythm generally arises first in the visual region, and thence spreads over the rest of the brain surface. There is some elusive connection between the cortex at the back of the head and the rhythm—and so also between the visual centers and the rhythm. But why light should have prime influence over alpha waves is altogether unknown. It has been hazarded that, because in man (and the higher animals) the visual centers are so great in extent, probability favors the origin of any possible and detectable rhythmic phenomenon here—where the largest number of similar nerve cells with similar functions would be simultaneously ready to co-operate in building up a synchrony of discharges. For a center of alpha activity to be detected, it must have a diameter of at least an inch.

As Dr. R. W. Gerard, professor of physiology, University of Chicago, expresses it:

"When an audience starts applause each individual claps in his own way and a chaotic medley results. But note that after a few seconds, without any deliberate attempt on any one's part, most people are clapping together in perfect time so that a large, slow, regular wave of sound is rhythmically produced. Just so are brain waves built of the added beats of many synchronizing cells."

Nerve cells have for more than a century been known to be electrically active. Messages passing along nerves are always accompanied by electric disturbances—indeed the electric discharge may actually be the message in each case. And, very recently, nerve cells have been proved capable of automatic discharge of electricity. Consequently, nerve cells can act as batteries, and periodically volley forth an electric display. Then, cells of the cortex, under conditions utterly dark to scientists, can, like the clapping audience, synchronize a multitude of individual reactions and give rise to a rhythmic display.

How does each cell generate its electricity? Why should myriads of cells harmonize? The physiologist is not ready to answer.

Concerning beta waves and other deeply hidden rhythms, extremely little has been established. Their precise origins and the conditions under which they manifest themselves remain dark. Their importance, however, is recognized. They contribute to the modern motion picture of the human brain. Such are the meanings now being read between the lines of alpha tracings. Meanwhile, the passage from alpha to omega in the brain remains among the grander distances of the cosmos. Yet Berger has guided us past still-secret alpha to beta at least, and perhaps even to gamma. A new beginning has been made in our struggles toward knowledge of this stupendous thing, the brain about which sentience glows like phosphorescence.

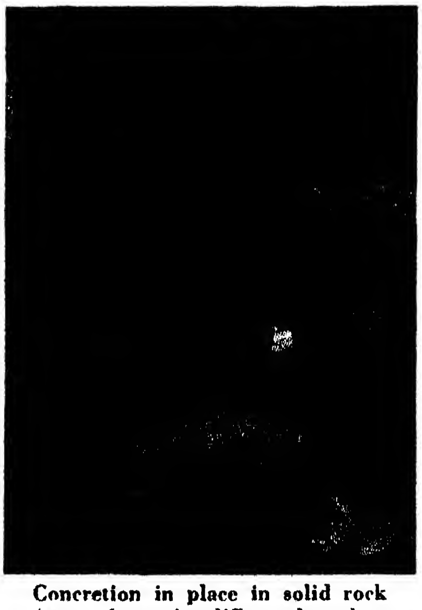
THE BIG CONCRETIONS OF OHIO

Odd Rock Curiosities that Intrigue Collectors . . . Formed in the Rock Where They are Found . . . A Peculiar Chemical Reaction is Their Origin

By ARTHUR DAVID

THOUSANDS continue to gaze with wonder upon Ohio concretions. Created some 300,000,000 years ago in the Devonian Period, these strange natural curiosities range from hickory-nut size to monstrous round or oval masses 18 feet or more in diameter. Maximum weight of some of the largest, now in partial or complete state of ruin, is estimated at about 300 tons.

Concretions are odd geological curiosities and always seem to fascinate their finders. Sometimes they are found loose, because they have long since been detached from their original positions in



Concretion in place in solid rock (seen above, in cliff) and, at bottom, a detached, fallen concretion

the rocks by natural forces, but when found where they first formed they look like the one shown high up in the cliff in the upper photograph, which is seen to be emerging from its ancient prison as the surrounding rocks gradually weather away. One might be forgiven for taking for granted that, originally, these objects were brought from afar and placed in the soft sediments as these were deposited, later to be encased as the sediments became rock. This appearance, however, is false, for they were formed in the rocks at the time these were first laid down as mud. This is proved by the fact that the regular bedding planes of the adjacent rocks continue through them, as is shown in the photographs. They are composed of some of the lesser components of the local rocks, those in shale often being of sulphide of iron (fool's gold). Usually they have at their centers a plant or animal fossil. Their formation is caused by material precipitated rhythmically from these nuclei, diffusing outward and reacting with other material diffusing inward from the rock. They take many bizarre shapes but are usually round or oblate spheroidal in form.

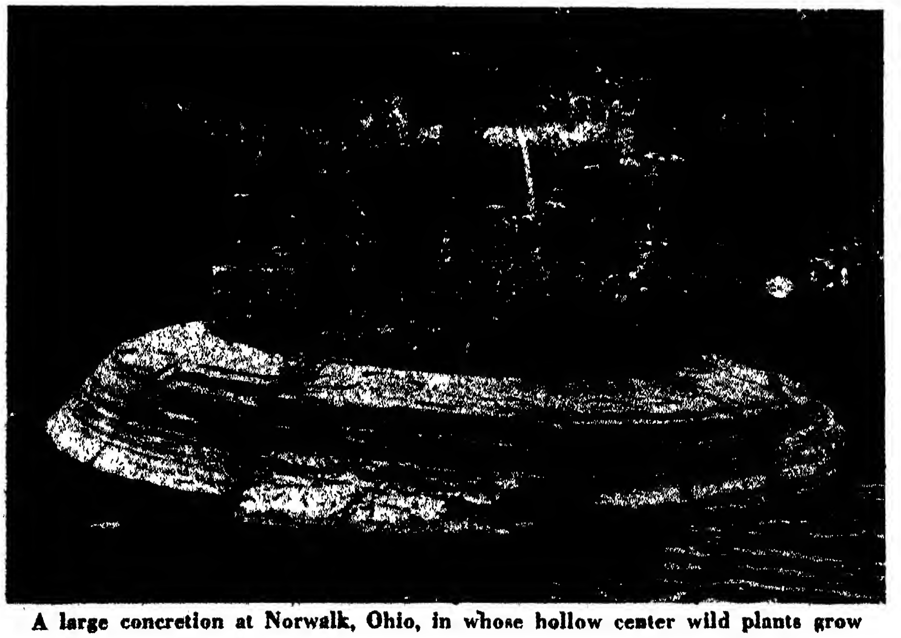
In Ohio, the largest concretions are found only in a belt of the Ohio Shale a few miles wide, from some distance south of Cincinnati, northward through central Ohio to the Lake Erie shore east of Sandusky. Concretions similar to those found in Ohio are observed in the same formation in the vicinity of Kettle Point, Ontario.

TO examine concretions in hope of finding fish, mollusk, or plant remains of Devonian age continues to be the quest of many geologists and natural history students. Often fossil hunters break up the dense formations with dynamite in order to examine the interior material. A request has been made to the Ohio Conservation Department to take steps to stop such needless damage to specimens.

In Ohio, after being enclosed in the shale through many geological ages, the concretions, through effects of weather and water, are gradually exposed by the elements in the shale river bottoms or by wave action on the shale beaches of Lake Erie.

A few years after a concretion becomes visible in a shale cliff from effects of weathering, it begins to lose its outer segments, often weighing hundreds of pounds. The irregular interior is then revealed. Some take on the appearance of weird faces that look out from their cliff windows often at elevations of 50 feet or more. This emergence from within the rocks to the outside world in time proves fatal, and now and then, when the shale support crumbles, the great masses tumble down into the streams or upon the banks. Disintegration by natural elements soon follows.

In the East Branch of the Huron River near Norwalk, Ohio, a singularly beautiful effect is produced yearly in the broken top of a concretion that protrudes about two feet above the water level of the small stream. This is shown in the lower illustration. Ice action has scooped out a bowl-shaped cavity ten feet long and six feet wide, and in this 300,000,000-year-old flower garden wild plants bloom—blue vervain, boneset and joepye-weed.



A large concretion at Norwalk, Ohio, in whose hollow center wild plants grow

ARTIFICIAL ECLIPSES

At Their Triennial Meeting the World's Astronomers Witnessed the Amazing New Technique of Observing Solar Prominences and Corona without an Eclipse

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE Stockholm meeting of the International Astronomical Union is over, and its members are scattering to the ends of the earth. Some of them have a long way to go, for there were members from as far east as Japan, and as far west as California and British Columbia.

More than 400 people—including wives and families—were listed on the official program. Of these, the largest delegation came from the United States —92 of them. Next in number were the British—69. Then followed our generous hosts from Sweden, of whom 64 were listed, but many more contributed to our enjoyment and comfort. France and Holland sent delegations numbering more than 20, and Belgium, Czechoslovakia and Germany were not far behind.

It would be an interesting study—quite in line with the present-day love of statistics—to interpret these "indices." Several factors obviously enter—the number of astronomers, professional and amateur, in the country; the time and distance required for a visit to Stockholm; and, last but not least, considerations of finance. The remarkable size of the American representation was doubtless considerably influenced by the attractiveness of a summer in Europe, and, in particular, the charms of a visit to Scandinavia. A gratifying feature was the presence of a considerable number of the younger members of the staffs of various observatories.

All who came were well rewarded, and in many ways. The traditions of hospitality which have grown up around the meetings of the Union in many countries were admirably maintained by our Swedish friends.

By invitation of the Government, our meetings were held in the Houses of Parliament—the law-makers being not in session. The halls of the Upper and Lower Houses furnished admirable places for the larger sessions, while the numerous committees had at their disposal the rooms of the Parliamentary committees with every possible convenience. Receptions and dinners, at the Royal Palace, the old Castle of Uppsala, and the new and magnificent Town Hall of Stockholm, and elsewhere, made the social side of the meeting memorable.

The scientific work of the Union had, as usual, been almost completed months before, by correspondence between the chairmen of the numerous technical committees and their members in all countries; and the draft reports of these committees, which were printed and distributed to all the members attending the meeting, form a volume of nearly 300 pages. At the sessions of these committees in Stockholm, there was often little to do but to give formal approval to the report, already well discussed by letters. Room remained, however, for discussion. For example, the committee on Stellar Spectra had to consider the adoption of a notation for the spectra of the Wolf-Rayet stars—those remarkable bodies which show broad, bright lines of highly-excited atoms. A sub-committee, composed of four or five experts in this specialized field, had, after long correspondence, agreed unanimously upon a scheme of classification, and upon detailed criteria for the distinction of the various sub-types. Since there appear to be two parallel sequences of these stars—one showing strong lines of nitrogen and the other of carbon—it was agreed to distinguish them by the chemical symbols C and N, appended to the W which denoted the general spectral type; but how? Should one recommend W_n8 (with a subscript letter) or Wɴ8 (with a small capital on the line), or WN8 (with a large capital)? (The figures 5, 6, 7, 8 . . ., which represent the degree of excitation of the atoms, were generally accepted.) This apparently small point led to 20 minutes of lively and very useful discussion of practical matters such as the difficulty of handling small capitals on a typewriter, and the practices of printing-offices and proof-readers in various countries, and when a decisive majority finally decided for the large capitals, there was a feeling that a great deal of annoyance to future authors, typists, and proof-readers had been avoided. Such matters may look small at first; but the adoption of a scheme of classification (in practice as well as in theory), is one of the main services which can be rendered by an efficient international organization.

So well was this work done in the various committee sessions, that the final "General Assembly" ratified their reports without modification.

There was much, however, of more general scientific interest. We visited the new Stockholm Observatory—beautifully situated on a wooded hill near the summer resort of Saltsjöbaden, a dozen miles from the city, with fine equipment, including a 40-inch reflector, and an able and enthusiastic staff—and admired the important work which is being done by Professor Lindblad and his colleagues, especially in the study of the spectra and absolute magnitudes of faint stars. At Uppsala, a group of spectroscopists, at Dr. Edlèn's laboratory, saw spectra running down to a wavelength of 12 Angstroms—1/500 part of that of yellow light—and learned, with great satisfaction, that he and Dr. Swings, of Belgium, have almost completed an analysis of the third spectrum of iron—the most important, to the astrophysicist, of all spectra which had not previously been observed.

By common consent, however, the most noteworthy scientific communication made at the meeting came from the French astrophysicist Lyot. The story has been told long ago in these columns how he attacked the supposedly hopeless problems of observing the solar prominences without a spectroscope, and the solar corona without an eclipse; and how he solved them by the application of optical principles which were long familiar, but which no one had had the inspiration to utilize. [See December, 1932, and January, 1934.—*Ed.*] By making a telescope with perfectly clean lenses, and cutting down scattered light in every way, and by observing on the Pic du Midi in the Pyrenees, at a high altitude and in very clear air, he succeeded, some years ago, in observing the prominences by direct telescopic vision, and the bright lines of the coronal spectrum on any clear day.

Now, with technique improved by experience, he showed results which are simply amazing. On his recent spectra, the bright coronal line in the green looks as strong on photographs taken in broad daylight as it does on many spectra taken during eclipses, while the opportunities

for exact measurement are better. His plates show 11 bright coronal lines, from the ultra-violet at 3388A to two newly discovered lines far in the infra-red, at 10747 and 10798. What is more, he has succeeded, by utilizing the finest days, in obtaining direct photographs of the inner part of the corona in full daylight. It will at last be possible to learn how the corona changes from day to day, or even from hour to hour—instead of waiting a year or more to find its form utterly different at the next eclipse.

Most remarkable of all were long series of moving pictures of the prominences—taken through a red screen, which transmits only the region of the spectrum near the red hydrogen line, but without the aid of a spectroscope or spectroheliograph.

During the summer of 1937, when a number of great eruptive prominences appeared, some of them were followed for hours, with exposures taken at intervals of a minute or so. The resulting films, when run through an ordinary projector, show what happened, speeded up 600 times, and present a bewildering picture of solar activity.

FROM the main mass of a prominence, perhaps 100,000 miles above the Sun's surface, great flakes and patches of luminous hydrogen break loose, and fall into the Sun. Others stream off sidewise, rising at first, and then falling along the curve of a great arch. Direct upward motions occur but rarely; those to the side are the most frequent.

In the films which were exhibited, the same set of pictures was shown three times over, in immediate succession—to the great advantage of the spectator, who, having seen the general course of the phenomena, could fix his attention the second time on some particular detail and study it. At times, bright clouds formed apparently in empty space. This confirms an observation made more than 50 years ago, visually, by the writer's old teacher, C. A. Young. To catch the moment of such an appearance upon plates taken with an ordinary spectroheliograph, at intervals of three or four minutes, is almost impracticable; but the motion picture cannot miss it.

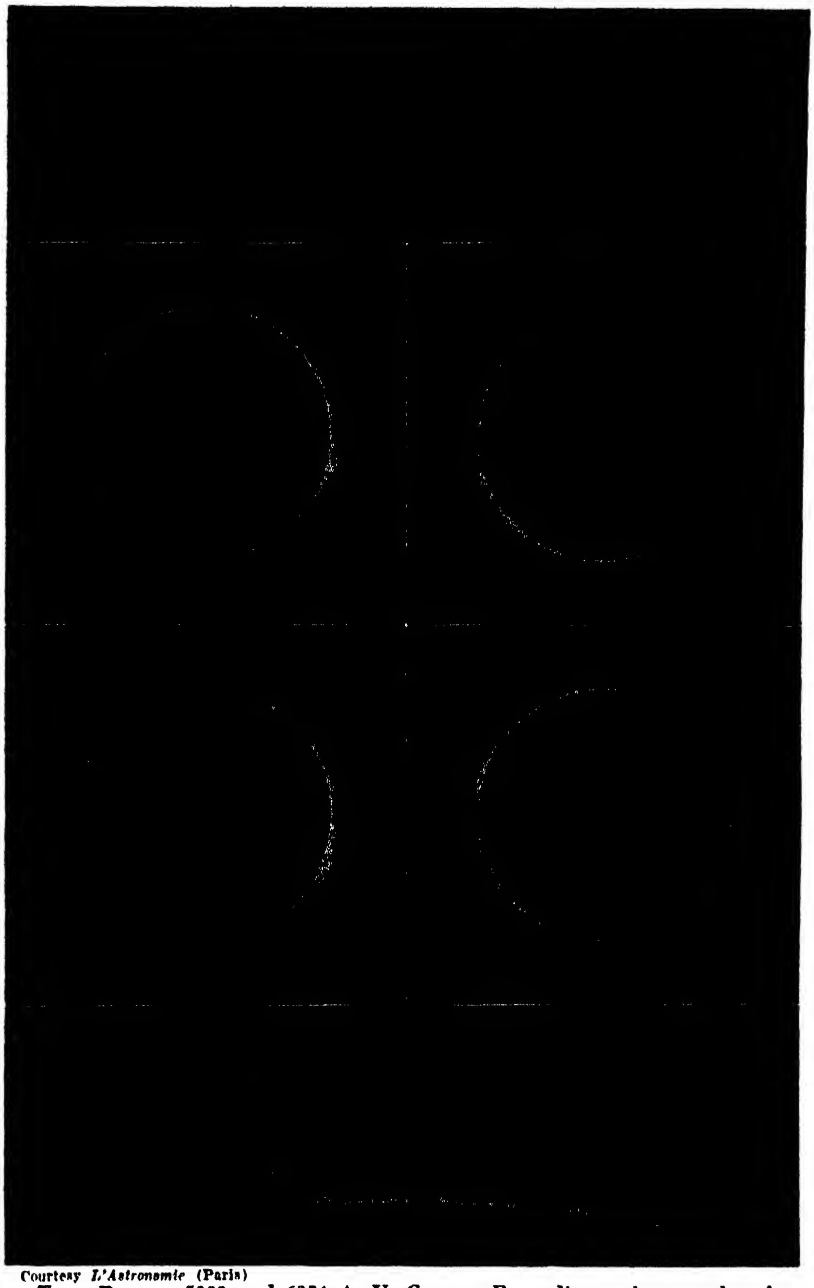
Most remarkable of all was a film in which a huge luminous jet burst from the Sun, struck a prominence-cloud above, and apparently blew it to fragments—with a change so rapid that the eye could hardly follow it on the screen.

Moving pictures showing these extraordinary changes in prominences were obtained two or three years ago by the McMaths, at their private observatory in Michigan, with the most ingenious spectroheliokinematograph of their invention. The great activity of many prominences, and the motion along curved arches, are excellently shown in these photographs; but those which were taken a year or two ago lack the fine detail of Lyot's pictures. In one respect, direct photography has the advantage. If a moving mass of hydrogen has a considerable velocity toward or from us, the bright lines it emits will be shifted in wavelength; they will go off the second slit of the spectroheliograph, and the eruption will not show on these photographs, while, of course, it will appear on those taken without a spectroscope. The newer work, therefore, is more decisive than the older on the question whether bright patches of hydrogen appear in "empty" space near the sun.

In general, the two methods of observation are not rivals, but allies—each being able to contribute something which the other does not. It is to be hoped that both will be actively continued.

The nature of the forces which cause these extraordinary motions is hardly understood at all. The luminous matter descending along an "arch" appears often to be sucked into a sunspot, or into some point near it. It will take years of study before the full advantages of all phases of this new method of observation are realized.

At the concluding session the Union elected Sir Arthur Eddington as President for the next three years—a choice everywhere approved—and decided to hold its next meeting, in 1941, in Switzerland—the place to be determined later. We are on our way home now, hoping to have (collectively and as a profession) results as good to present then as we have just seen.—*At Sea, SS. Stavangerfjord, August 23, 1938.*



Courtesy *L'Astronomie* (Paris)

Top: **Rays at 5303 and 6374 A. U.** *Center:* **Four direct photographs of the solar corona.** ***Bottom:*** **A protuberence having an open and tremendously wide arch, seen rather sketchily in the half-tone reproduction, high above the center. This image was taken from a motion picture film**

MACHINES PICK COTTON, BUT—

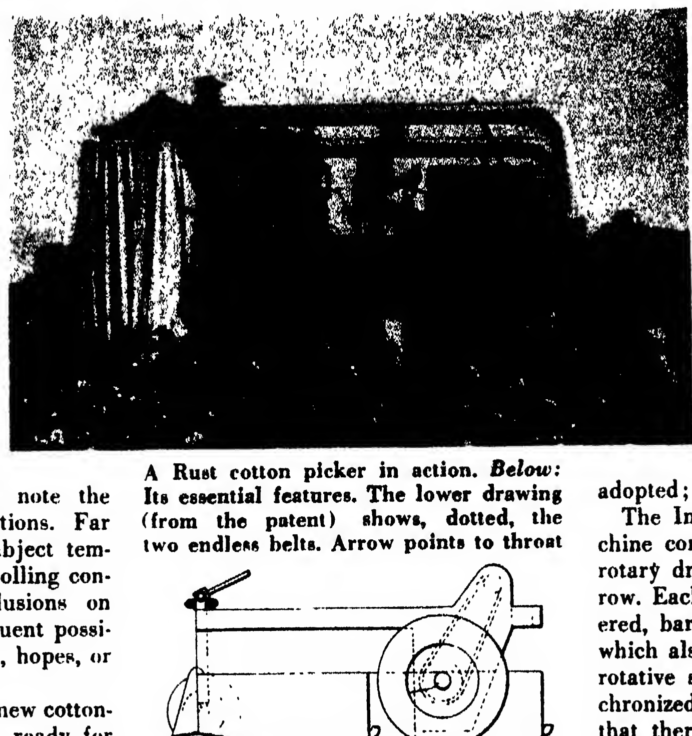
Mechanical Cotton Pickers Coming . . . To Solve Planter's Biggest Problem . . . Complex Factors . . . Adoption Very Slow . . . No "Economic Revolution"

By F. D. McHUGH*

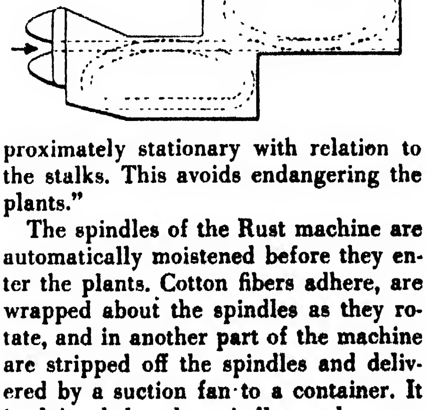
SCORES of articles, in newspapers and magazines habituated in recent years to the use of superlatives, have told the public that cotton-picking machines are destined to cause a "social upheaval" in the South, to threaten an "economic revolution" there. These machines, it is claimed, will revive the growing of this major crop in some sections. They will, it is predicted, throw into the ranks of the unemployed millions of hand pickers of cotton, remove their source of livelihood "in five years." One noted newspaper has repeatedly stated that they will make useless something like 5,000,000 horses and mules, supposedly now used during cotton-picking time. These machines, we are told, will salvage the tenant farmer (with the help of political reformers, the C. I. O., a "new relationship between southern whites and Negroes," and the "socially minded folk" of the nation), will give him, apparently, a new position of social, economic, and political power.

Brash statements, these! Predictions are always dangerous, but especially so when applied to new labor-saving inventions. One has but to scan the history of other such developments to note the boomerang effect of predictions. Far better is it to consider a subject temperately, to analyze the controlling conditions, and to base conclusions on background facts and consequent possibilities rather than on wishes, hopes, or fears.

Although there are several new cotton-picking machines practically ready for the market, most of the recent nation-wide comment on them has been inspired by the one developed, after something like 11 years of experimentation, by John D. and Mack Rust of Memphis, Tennessee. Of simple and clean design, this machine employs as its working principle the affinity of cotton fibers for wet surfaces; hence it has no hooks or teeth on its collecting spindles. In the words of the inventors, "it consists primarily of an endless belt carrying several hundred smooth wire spindles. As it passes over the row of cotton, the rotating wire spindles enter the plants. The speed of travel of the spindle carrier (and the consequent movement of the spindles in a backward direction during contact with the plants) is approximately equal to the speed of the forward travel of the machine. The spindles, therefore, while in the plants, rotate in a position ap-



A Rust cotton picker in action. *Below:* Its essential features. The lower drawing (from the patent) shows, dotted, the two endless belts. Arrow points to throat



proximately stationary with relation to the stalks. This avoids endangering the plants."

The spindles of the Rust machine are automatically moistened before they enter the plants. Cotton fibers adhere, are wrapped about the spindles as they rotate, and in another part of the machine are stripped off the spindles and delivered by a suction fan to a container. It is claimed that the spindles probe every part of the plant, that only mature cotton is gathered while immature and faulty cotton is left behind. However, much trash—leaves, small limbs, and dirt—is gathered in; and because at harvest time some leaves are still green and may be bruised by the machine, a green stain will be imparted to some of the lint.

Another mechanical cotton-picker is that developed after 30 years of intensive research and experimentation by the International Harvester Company under the leadership of Mr. E. A. Johnston, Vice President of the company in charge of engineering. This machine also employs a large number of probing fingers of steel. In this case, however, a comparatively short, tapered spindle with several rows of inclined barbs was adopted; in fact, it is quite stumpy.

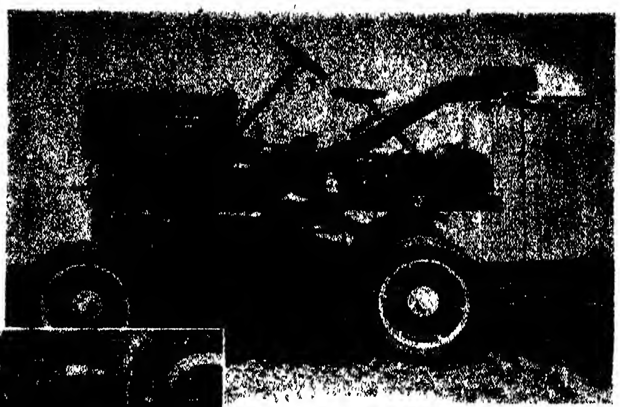
The International cotton-picking machine consists of two vertical, parallel, rotary drums which straddle the cotton row. Each drum carries 154 of the tapered, barbed, picking spindles, each of which also rotates on its own axis. The rotative speed of the drums is so synchronized with the speed of the machine that there is no raking of the plants. Since the cylinders are located, one in advance of the other, on opposite sides of the picker throat, the spindles protrude across the throat and penetrate the plants from opposite sides so that contact is made with all mature cotton on each plant. On the opposite side of each drum is a doffer which removes the cotton from each spindle and drops it onto a conveyor belt which carries the fiber to bags. The emptied spindles are then sprayed with a fine mist to remove any green stains caused by bruised foliage.

A THIRD machine which seems about ready to go on the market is the Hanauer-Berry-Gamble cotton picker, the result of some 25 years of experimentation. Mr. A. M. Hanauer writes that

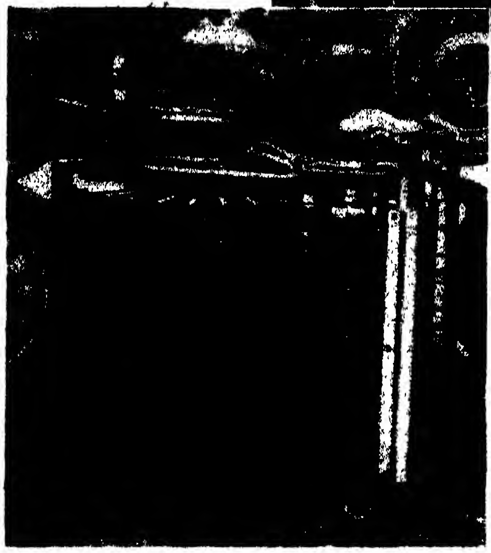
*The author of this article, a member of our editorial staff, is himself a southerner with a broad, first-hand knowledge of the problems incident to the growing and harvesting of cotton and its manufacture into textiles.—*The Editor.*

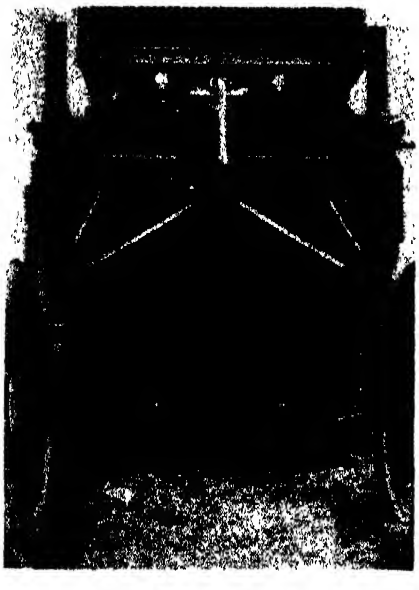
". . . we feel that we have the problem [of mechanical cotton picking] licked." This machine also has two vertical cylinders which straddle a cotton row. These cylinders are directly opposed, and each has over a thousand rotating spindles barbed in such a manner as to do the least possible damage to the plant. As the machine moves along the row under its own power, these spindles penetrate each cotton plant from both sides simultaneously. Seed cotton (mature lint and seeds combined), wound on the spindles, is doffed when the spindles reach the back position. Suction then carries the cotton to a container.

In Texas, a fourth cotton-picking machine has undergone numerous tests and, according to reports, has proved a strong competitor to the others in results achieved. A. R. Nisbet and his son, J. L. Nisbet, and H. G. Wendland are the developers. Its name, Wind-Roll, is descrip-



One model of Hanauer-Berry-Gamble picker and, *below center*, with cover removed, the spindles of one of its vertical cylinders. At left below is the front of its throat, with its spindles meshing





tive of both its design and its operation. The picking element consists of a pair of mesh rollers which roll the cotton out of the bolls as the cotton plant is blown by a blast of air, first to one side against one roller and then to the other side against the second roller 20 inches behind the first. The mesh of the rollers holds the loose fiber until a half revolution has been made, when the same blast of air blows it off the cylinder. The released fiber is caught by a revolving screen and carried to a suction pipe which empties it into bags.

Other machines are in the offing but these four are the ones most widely discussed among agricultural experts and engineers. They are all important; make no mistake on that score. That they have all reached the practical stage almost simultaneously is pure coincidence. Their developers did not accidentally bump into a new problem and solve it forthwith; cotton picking is and always has been the costliest operation of cotton growing and much thought has been given to the job of lowering that cost. Attempts to ease this burden of the cotton planter were doubtless made by the ancient Egyptians but have been made intensively in this country since the first mechanical cotton picker was patented in 1850. Since then, numerous pickers have been invented, and no less than about 850 patents have been granted by the United States Patent Office on devices to aid or supplant the human picker. This large number of inventions serves to emphasize the complexity of a problem which can be understood only by a consideration of the many factors involved, peculiar to cotton growing.

The first of these is, naturally, the age-old practice of hand picking, celebrated in song and story as a time of joy among the pickers who are preponderantly Negroes. There is, however, little romance in the job; it means hard work under hot suns, low pay for the pickers, and a disproportionately high labor cost for the planter. In most sections of the South, the pickers go into the fields equipped with no more than a large bag which trails on the ground. The picker's deft hands harvest mature cotton from scattered open bolls, leaving the dried burr on the stalk. Periodically, each picker carries his bag load to a central point where it is weighed and then dumped on a common pile or into a wagon or truck. It will be noted that horses and mules take no part in this actual picking operation.

An expert picker can pick several hundred pounds of seed cotton a day, but the average is about 150 pounds, which makes about 50 pounds of ginned cotton, the seeds accounting for the remainder. While the picker gets from 35 cents to $1.25 for picking a hundred pounds of seed cotton, this wage takes from the planter up to half the price he will get on the market for his ginned cotton.

Besides the elements of time and expense involved in hand picking, there are other factors which complicate the picture. Cotton does not mature all at one time in any one field; hence it is usually necessary to pick over a field several times. Rain may come at the wrong time and beat some of the loosely hanging fiber to the ground, spatter grit on some. Continuous rains sometimes wet the cotton so that it cannot be picked for weeks simply because gins cannot take care of wet cotton. Furthermore, dampness often causes the seed to sprout in the boll or on the ground so that the clinging fibers are damaged. Labor in any given locality may not be sufficient to harvest the cotton as fast as it ripens, and some fiber may weather, take on a gray, stained appearance which lowers its grade—and its price—on the market.

In some parts of Texas, a method known as "sledding" or "stripping" cotton was begun some 11 or 12 years ago, and other sections are studying the practice. The stripper, originally homemade as a sort of large box on a sled but now built on wheels by several manufacturers, rakes cotton off the plants with a large comb-like row of fingers. The comb, however, gathers an enormous amount of trash—burrs, twigs, leaves, and dirt—as it is drawn over the cotton row. Consequently, the cotton must go through a separate cleaning process which cannot thoroughly clean; hence the grade of cotton harvested in this manner is below that of cotton picked by hand. Nevertheless, the cheapness of the practice and the fact that it prevents a total loss of the crop when hand labor is unavailable make it attractive to many planters.

The mechanical cotton-picker that can supplant these methods and overcome

the several important handicaps mentioned must, obviously, be most ingenious. Without attempting comparisons between the four machines discussed, it may be stated that all have shown excellent results—under test conditions. Roughly, we might average the amount picked by any one of them as seven or eight times as much seed cotton in an hour as a hand picker turns in after a day's labor. The net saving to the machine-using farmer may range from $4.00 up to $15.00 a bale. To pick this much, however, the testers of the machines naturally chose clear days with large quantities of mature, dry cotton available in wide, flat fields. Thus the comparison is partially fictitious, for on thousands of farms such a combination of conditions is rare, often unapproachable.

A CONSIDERABLE amount of the cotton grown in this country comes from thousands of farms in rolling, hilly sections. Here the cotton fields are relatively small, rows are short and curved to follow contours, and terraces and jagged gullies abound. No mechanical picker in existence could operate economically on such farms.

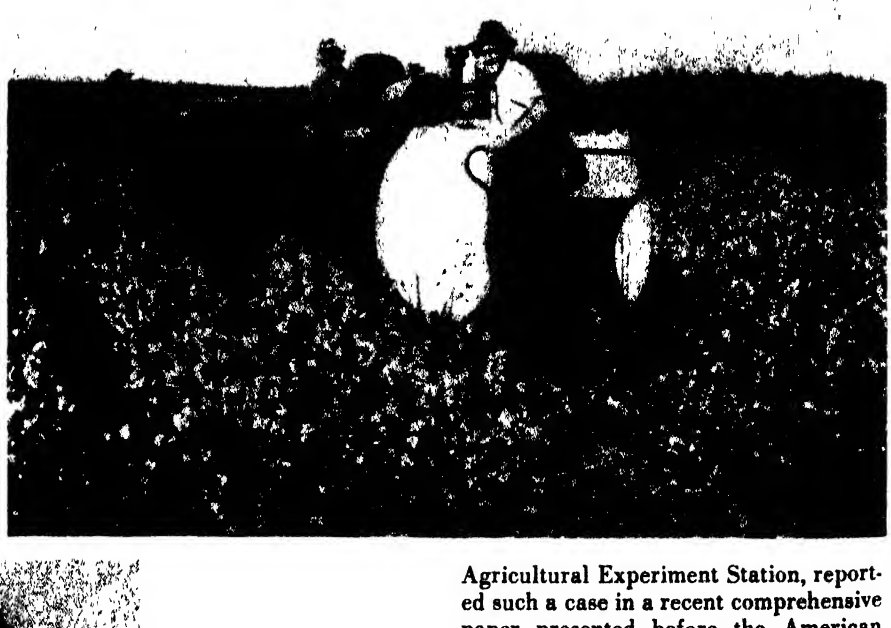
There are many varieties of cotton, identified by fiber length and plant size and shape. Fibers range all the way from 5/8 of an inch to 1 1/4 inches long, while stalks vary from a few inches in height to five or six feet. The yield, depending on variety, weather, soil, fertilization, and other factors, may be anywhere from a quarter of a bale to two bales per acre. These are vital statistics having an important bearing on the possibilities of mechanical pickers. If to these is added the problem set up by the continuous rains mentioned previously, an increased handicap for the machine becomes apparent. Such rains bring out rank new growth of limbs and foliage and often a second growth of blooms and bolls. While the mechanical picker awaits the coming of frost to kill this green growth, the mature fiber on the same plants would be weathering and deteriorating. Hand pickers do not have to wait. Furthermore, while the hand picker gets all mature cotton the first trip, the machine must usually make a second run, besides knocking some cotton to the ground.

It is said that the mechanical picker is not perfectly discriminatory, that it does pick some of the green cotton; and green cotton is wet. Gins cannot handle this satisfactorily and if some wet cotton does get into the bale there is a lowering of the grade of the whole bale, if not also spontaneous combustion.

Under the present system of grading cotton, its color in the bale, the length of its staple, and its trash content all combine to determine its marketing price. Mechanical pickers almost invariably add a further element: the green stain from bruised leaves and bolls. As has already been hinted, all mechanical pickers will increase by several hundred percent the amount of trash gathered with cotton. Beaters in the opening rooms of all cotton mills remove this trash at extra expense but the matter of the green stain is a definite problem that still has to be solved.

Should the cotton-picking machine ever supplant the hand picker, labor will not have entirely "lost its livelihood" but only 40 to 60 days' work per year. The cotton-picking season lasts just that long. Yet much of that same labor is needed—not in such numbers at any one time, it is true—for other work on the farm, for planting, plowing, "chopping" cotton, and "laying by." True, a certain amount of labor will be forced to leave those plantations that are already so highly mechanized that the planters are supporting labor throughout the year in return for six weeks of essential work. On the smaller farms there is seldom an importation of cotton pickers from elsewhere; the regular farm hands and the farmer's whole family manage to get in the cotton without undue difficulty. Where it is necessary to import cotton pickers, only too often it has been impossible to find enough hand laborers when most urgently needed. There are times when considerable cotton must be left in the fields to rot for want of sufficient pickers.

On the other hand, sometimes labor happens to be so plentiful that cotton will be picked faster than gins can handle it. H. P. Smith, of the Division of Agricultural Engineering of the Texas Agricultural Experiment Station, reported such a case in a recent comprehensive paper presented before the American Society of Agricultural Engineers. He stated that in 1937 in the High Plains region of northwest Texas, three counties produced 425,000 bales. "Labor was available to harvest the crop so rapidly," he said, "that although the gins operated on a 24-hour schedule, they were overrun with cotton. Farmers, until stopped by risk insurance inspectors, unloaded hundreds of bales in the gin yards. They then harvested and piled cotton in the fields to wait until the gins could handle it." From what has already been said, it is easy to imagine the deterioration that must result from such a practice, espe-

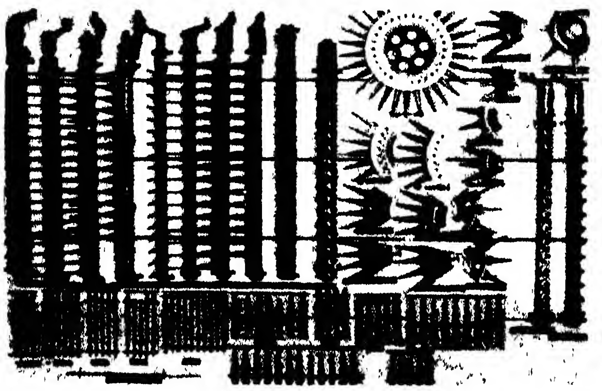


An International Harvester Company cotton picker in a fine field of mature cotton. This head-on view shows the bags of picked cotton. At left is presented a view clearly showing the picking throat at 1, and the dummy throat which merely straddles, but does not pick, another cotton row

cially if rains come to beat dirt into the piles of staple or if the seeds sprout. It is just as easy to understand how the mechanical picker could make this a common occurrence instead of a relatively rare one.

With hand labor, there has never been any difficulty experienced in picking the many different varieties of cotton—whether the staple is long, medium, or short; the stalk stunted or tall; the foliage rank or sparse, green or dead; the fruit plentiful or meager, bunched or scattered. Mr. Smith, whose station is said to be one of the first to gather data on mechanical pickers, stated in his paper that it was recognized that "the efficiency of any mechanical harvesting device would be greatly influenced by plant characteristics." Mr. Johnston, of International Harvester, says that "the problem is to breed a variety of cotton plant that is not so rank in growth, but which will be satisfactory in its yield and quality of staple." At present, a similar form of cotton plant will not be found in two successive years or in two different areas in one season. Mr. Smith's paper (which is to be published in the magazine *Agricultural Engineering*) discusses this breeding problem at great length, stating that already several years have been devoted to cotton breeding and study of the characteristics of various types as related to the machine. The indications are that a number of years will elapse before the problem will be entirely solved.

Another view, from the left rear, of a slightly different form of cotton picker made by International Harvester Company



Some of the many kinds of smooth and barbed, long and short spindles tested in the development of the machine above

Once a variety of cotton satisfactory for machine harvesting has been produced, there will come the job—and any southerner will affirm that it will be a slow and extremely difficult one—of overcoming the tradition-bound, cotton-growing habits of southern farmers. For many years they could have been growing less cotton but of a much better grade, thus releasing acreage for other crops; but no, they have always grown one variety in one way and in about the same quantity and are satisfied to continue the old régime. This conservatism will militate as much against the introduction of a new staple as against the new-fangled machine.

The initial cost of cotton picking machines would not be prohibitive to the larger plantation owners for, already, the Rust Brothers have promised a stock model to sell for around $1000. Other manufacturers will probably set their prices accordingly. Then, later, competition may be expected to lower prices considerably. Even so, numerous small but independent growers will find it impossible to tie up so much capital in a machine which is idle for over 10 months per year. Only too often these farmers make but a bare living plus enough to buy the next year's seed and fertilizer. Co-operative ownership in a given community will help to solve this problem but probably will never completely erase it.

COTTON, as may be seen by the foregoing discussion, is not a mysterious and romantic source of untold wealth needing but the magic touch of a simple invention, as it is pictured by outsiders and by some writers who should know better, but rather an agricultural product the harvesting of which is beset with more complexities than is the harvesting of any other important crop. Too much remains to be done in solving the picking problem for anyone to say that present mechanical pickers will cause a social upheaval or an economic revolution in the South. They will cause neither. Mr. Smith, Mr. Johnston, and other noted agricultural engineers agree with the writer on that point. In fact, it is not wholly a question of cotton-picking machines displacing human pickers; rather a lack of sufficient hand labor caused adoption of the sledding and stripping method in Texas and has given great impetus to the perfection of mechanical pickers. Further, this lack of labor seems most prevalent in flat country where the machine can be used most efficiently. In time, picking machines may revive cotton growing for some sections where labor costs had previously stopped it, but they will destroy the crop for some other sections that can neither use the machines nor compete with their cheaper cotton. Granting the widespread adoption of picking machines in the distant future, many of the displaced hand pickers may remain on the same farms for other work. Furthermore, their loss of cotton-picking wages may conceivably be more than offset by a larger wage for this other work, if the farmer makes a larger margin of profit due to the savings effected by the machine. On the smaller farms, the machine will have the good effect of releasing the farmer's children from a difficult job, but this will not be "displaced labor" in the true sense.

When the "tumult and the shouting dies," the cotton-picking machine will be accepted for what it is, for what it will do, and when. It is now considered by agricultural engineers no more as a thing to fear than as a sure cure for all the social and economic ills of the South. When it has been further perfected and when related problems have been worked out, it will be adopted by many cotton planters and will slowly have its influence on the South. There will be a gradual adjustment, the effect of which will be scarcely noticeable at any given time. Doubtless, after a period of many years, cotton-picking machines will be quite generally used throughout the South. A reasonable estimate of that "period of years" would be somewhere between 25 and 50.

Cosmic Radiation

Science Still Remains Uncertain What the Cosmic Rays Are, Where They Come from, How They Were Formed and When . . . Mainly They are a Puzzle

By P. M. S. BLACKETT, M.A., F.R.S.
Professor of Physics at Manchester University; formerly Professor of Physics, Birkbeck College, University of London

THE study of cosmic radiation is rather a curious one. It is related ultimately to astronomy as well as to geophysics and to physics. The subject started about 1900 with the discovery by C. T. R. Wilson, and by Elster and Geitel, that the air in a closed vessel had a slight residual conductivity. The apparatus used for these early experiments consisted of an ionization chamber. A simple form of this apparatus consists of a metal box in which is suspended an insulated wire carrying a gold leaf; when charged electrically, the movement of this leaf records the electrical conductivity of the gas in the box. With such a simple apparatus as this it was found that there was a residual conductivity of the air, which could not be explained by the effects of the known radioactivity of the earth's crust, and which was probably due to the presence of some very penetrating radiation. In fact, C. T. R. Wilson himself, in 1901, speculated as to whether this residual ionization might not be due to some radiation coming from sources outside the atmosphere, either electromagnetic radiation, like X rays, or corpuscular rays like cathode rays, but of enormously greater penetrating power. Since that time at least 1000 researches have been made on the subject of cosmic rays and a great many facts have been found out. We know now that this residual ionization is, in fact, due to atomic particles of enormous penetrating power coming into the earth's atmosphere from some sources outside the solar system, but exactly what these particles are, or where they come from, or how they were formed, or when, we still do not know.

Soon after the earliest experiments, ionization chambers were taken to different places on the earth to find out whether this residual ionization varied from place to place. Then a great series of experiments began in which ionization chambers were taken up mountains, in balloons, lowered down to the depths of the sea and carried in airplanes. The crucial experiments, which showed the cosmic nature of the rays, were those of Hess in 1911 and 1912, who took ionization chambers to a height of 5000 meters in balloons. Hess found that the ionization due to the rays was larger at a great height than at sea level. This showed conclusively that the rays causing the ionization must have come downward from the top of the atmosphere, and not upward from the earth; for if they had come upward from the earth, they would decrease in intensity by absorption as one went up. Hess also found that the rays were equally intense both during the day and at night, and also during an eclipse of the sun. This showed that the rays could not come from the sun, because if they had, their intensity

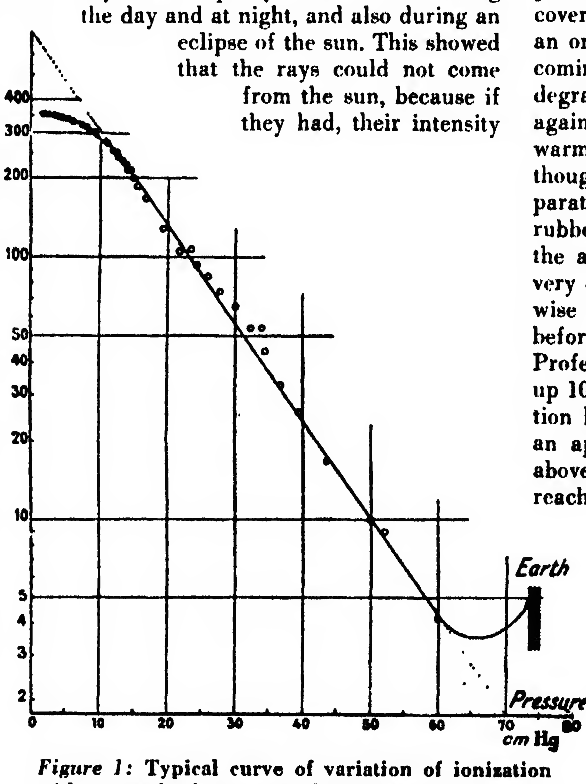


Figure 1: Typical curve of variation of ionization with atmospheric pressure. Numbers at left refer to ions per square centimeter per second in standard air

would be much less at night, or during an eclipse. Thus it was these experiments which led to the rays acquiring the name of "cosmic."

Since that time a very great number of experiments have been made to find out how the cosmic radiation varies in intensity in the atmosphere. Perhaps the most beautiful of these, and the most successful, have been the balloon flights of Regener and lately those of Millikan, who send very light recording apparatus up to great heights by means of small, hydrogen-filled rubber balloons. A small ionization chamber, which is made to record automatically the intensity of the rays on a photographic plate, together with the barometric height and the temperature, is made to weigh only a few pounds. This is enclosed in a light frame covered with Cellophane, which acts like an ordinary greenhouse; the sun's rays coming in through the Cellophane are degraded into heat and cannot get out again. In this way the apparatus is kept warm at about room temperature, even though the temperature outside the apparatus is -50 degrees, Centigrade. The rubber balloons which are used to take the apparatus up have to be examined very carefully for small pinholes, otherwise they are apt to burst prematurely, before the desired height is reached. Professor Regener sometimes has to stop up 100 or so tiny holes with rubber solution before using a balloon. With such an apparatus heights of 30 kilometers above the surface of the earth have been reached, where the pressure of the atmosphere is only about 1 percent of that at sea level. It is found that the intensity of cosmic radiation is about 200 times as great as on the ground, confirming, of course, the view of Hess that wherever it is the rays come from it is at least outside the earth's atmosphere. Figure 1 shows a typical curve of the variation of the ionization with the pressure of the atmosphere.

With similar, but much larger apparatus, the ionization due to cosmic radiation has been studied under water, down to great depths. Regener, again, has measured the ionization down to depths of 280 meters below the surface of Lake Constance, and finds that their intensity is only about 1 percent of that at sea level. So from the bottom of Lake Constance to the top of the stratosphere the intensity of cosmic rays increases by a factor of over 10,000 to 1. The enormous penetration of the rays, a penetra-

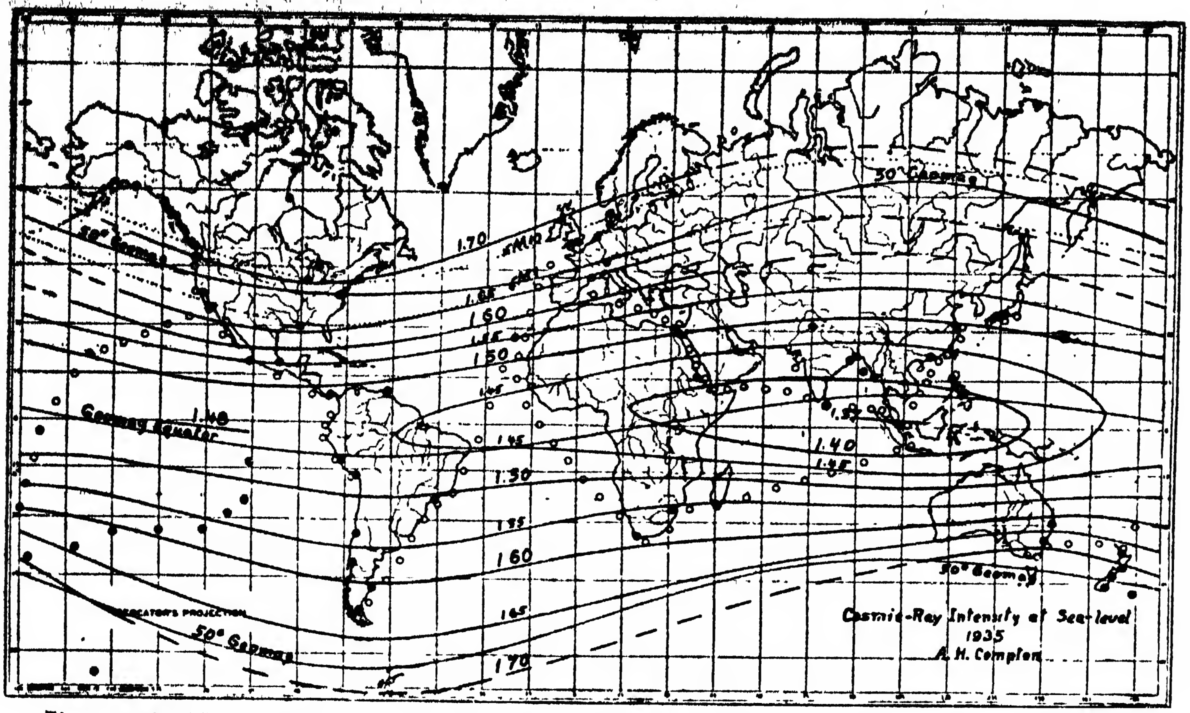


Figure 2: World map showing curves of equal cosmic-ray intensity (isocosms). This map makes evident the approximate parallelism of isocosms with geomagnetic latitude and auroral frequency (curves M_1 and M_{10})

tion quite unexpected in the region of atomic physics, leads naturally to the conclusion that the rays must be of immense energy. The most penetrating atomic rays previously known, the gamma rays from radium, can penetrate only a few meters of water. Thus, the cosmic radiation is many hundred times more penetrating, and is therefore likely to be very much more energetic. In fact, it can be easily estimated that, to explain the very great penetrating power of some of the rays, it is necessary to assume energies up to 10^{11} electron volts.

The next great series of experiments consisted in carrying ionization chambers all over the world. Expeditions to the equator, to near the north magnetic pole, expeditions on mountains and in ships, all these have been used to find out how the intensity of cosmic radiation varies with the latitude and longitude and the height of the place of observation. This aspect of the study of cosmic rays can be called the geophysical aspect and is, in fact, closely related to the study of the variation of the earth's magnetic field over the surface of the earth. In Figure 2 are shown the lines of equal cosmic-ray intensity—or isocosmic lines, as they are called—and these lines run very nearly parallel to the lines of equal geomagnetic latitude. They also run nearly parallel to the lines of equal auroral frequency. The explanation of this relation can be given shortly by saying that the cosmic rays as they reach the upper levels of the earth's atmosphere are mainly electrically charged particles of very great energy. These particles are deflected by the magnetic field of the earth so as to reach regions of higher latitude more easily than regions near the equator. This behavior is very similar to that of the charged electrical particles which are held to be the origin of the Northern Lights. In fact, the theory of the *aurora polaris*, proposed many years ago by Birkeland and Störmer, applies almost unchanged to cosmic radiation. The intensity of cosmic radiation is found to be nearly constant from latitude 50 degrees north up to the poles, but decreases toward the magnetic equator, the decrease amounting to about 15 percent. Figure 3 shows the results obtained during a voyage from Southampton to Cape Town. At greater heights, the increase from the equator to the poles is much greater.

THIS study of the intensity of cosmic radiation at great heights and in different latitudes is of the highest importance, but our knowledge is at present extremely fragmentary and quite inadequate for many purposes. In order to test theories as to the nature and behavior of the rays, we really want to know the intensity of the cosmic radiation from sea level right to the top of the atmosphere at all latitudes, but so far it has not been possible to do many experiments of this type.

Apart from the free balloon ascents by the technique already described, valuable results have been obtained by the use of manned balloons. This technique was first developed by Professor Piccard. It is well known that it is not possible to live at a height above, say, 20,000 feet, without the use of oxygen—at least, if one cannot spend a long time acclimatizing oneself to the reduced pressure. One can go to a height of 40,000 feet or so if one breathes oxygen instead of air, but one cannot go very much higher, even breathing pure oxygen, unless one keeps up the pressure of the body artificially. There are two ways of doing this: one can place oneself, as did Professor Piccard, in a metal gondola, generally of spherical shape, which is sealed up and retains the pressure on the body above that of the air outside. The other method is to use a pressure suit; that is, a suit rather like a diver's suit, but in which the pressure is kept above that of the atmosphere. This method was used in setting up the altitude record for airplanes. With the former method Piccard and his collaborators and also some other investigators in America have reached heights up to 18 kilometers, carrying elaborate and heavy apparatus with them. In one such flight from Belgium, which ended somewhere in Central Europe, Dr. Cosyns measured the variation of the intensity of cosmic rays as he floated across Europe at a height of some 12 kilometers. He found, much to his surprise, that the cosmic radiation remained constant from about 51 degrees north to about 49 degrees north, and then dropped suddenly as he went farther away from the poles. This critical latitude of 49 degrees north, above which the cosmic radiation remains constant, is of great importance in all cosmic-ray theory. We have to try to explain exactly why the cosmic rays remain constant north of this latitude both at sea level and at great heights. At present there is no satisfactory explanation of these facts.

The next part of the study of cosmic radiation to be described is how the intensity varies with the time. Experiments have been made over periods of years to see if the cosmic radiation is quite con-

stant or if, and how, it varies. Some results are shown in Figure 4. The soft components of radiation—that is, the part of the radiation which has not a very great penetrating power—do show an appreciable variation with the time of day. There is a slight maximum about midday of the order of a few percent of the whole intensity. But when the soft radiation is filtered out by means of thick lead screens, the remaining penetrating component is found to be almost constant. The figure shows that this penetrating component does not vary more than a fraction of 1 percent throughout the day—that is, when the results are averaged over a very large number of days. This again shows, as did the early experiments of Hess, that the radiation cannot come from the sun—at least, if it travels in straight lines—for if it came from the sun it would be very much more intense by day than by night. One can, in fact, conclude from the constancy of the radiation with time that the rays, as they reach the earth, must be isotropic—that is, they must be coming from all directions equally; for if they were coming from any one direction predominantly, then since the earth is rotating, any part of the earth's surface would receive more radiation when it was facing the direction from which more rays were coming.

Thus, the constancy in time of the rays implies their isotropy in space. Now this is one of the most difficult things to explain about the cosmic rays, for it is very difficult to find plausible sources for the rays which are uniformly distributed with regard to the earth. As has been mentioned already, the sun is obviously excluded as a possible origin, but so also are the stars of our galactic system, for these are far from being uniformly distributed around the earth. If one looks at the night sky one sees a great concentration of stars which we call the Milky Way. There are many times more stars in this direction than in a direction at right angles, so if the rays came from the stars of the Milky Way there would be a greater intensity of the rays when the Milky Way is overhead. This means that the rays would show a variation with sidereal time, but careful investigations have shown that there is very little variation indeed. There is a small effect which is of great importance and which has only recently been detected, but the variation with sidereal time is very much less than would be expected if the stars of the Milky Way were the origin of the rays.

Now all the stars that one sees with the naked eye, or can see even with a large telescope, are members of a huge group of stars called the galactic system. This system contains some 30,000,000,000 stars. These stars form a kind of huge disk, of which the size can be roughly estimated as being 60,000 light-years in diameter and 5000 light-years thick. It may be noted that a light-year, which is the unit of distance often used by astronomers, is the distance traveled by a ray of light in a year, and is about 10^{13} kilometers. About 90 percent of the matter in the galactic system lies in this central disk, about half consisting of stars and about half of diffuse matter and of gas. The earth is situated somewhere near the central plane of the disk, but about 20,000 light-years from its center.

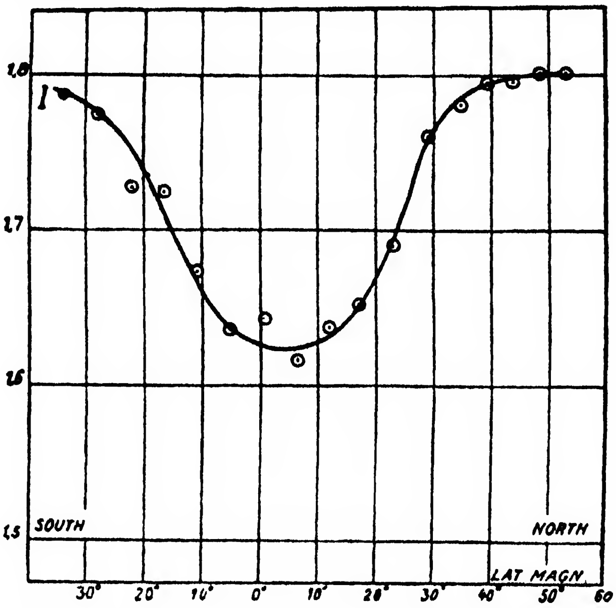


Figure 3: Variation of cosmic radiation with geomagnetic latitude. At left, ions per square cm per second

This whole galactic system constitutes a huge nebula analogous to, but probably rather larger than, the great spiral nebula in Andromeda. There is a great central condensation of stars near its center which lies toward the constellation of Sagittarius, this constellation lying in about the thickest part of the Milky Way. In recent years it has been discovered that the whole galactic system is in rotation, making one complete revolution in about 250,000,000 years. Since the earth lies so far from the center, it is traveling through space with a very large velocity, amounting to approximately 300 kilometers per second. It can be shown that the effect of this large velocity is to make the intensity of cosmic radiation slightly greater on the side of the earth which faces the direction of motion, as compared with the opposite side. Just in the same way as more raindrops are found on the windscreen of a moving car than on the back window, so the motion of the earth is revealed by the greater intensity of cosmic rays on one side. This fact was predicted by Compton, and has been recently found experimentally. The variation is quite small, being less than 1 percent in magnitude, but it seems fairly clear from the measurements of Hess and Steinmaurer, of Schonland and of Kohlhörster, that the predicted variation does really exist. This is a very important result, for it confirms the view, that I have mentioned above, that the cosmic radiation cannot have its origin in our own galaxy. Figure 5 shows the results of the variation with sidereal time which confirm Compton's predictions.

It is of interest to note that if the earth had been completely covered with cloud so that no stars could ever have been seen, it would still have been possible to show that the earth was moving very rapidly toward a certain direction in the heavens, or, more accurately, moving relative to something, the only property of the something being the power of producing cosmic rays. We will take it, therefore, that it is experimentally demonstrated that the cosmic rays are of extra-galactic origin.

WE must, therefore, seek for some extra-galactic origin for the rays which is uniformly distributed all 'round the earth. Now there are such bodies—in fact, the whole universe is filled with nebulæ—and these nebulæ are, in fact, nearly uniformly distributed around us. Each nebula may be considered to be another galaxy similar in principle to our own, but in general of rather smaller size. But if we imagine that these nebulæ are the origin of the cosmic rays, we meet with a great difficulty, for it has been shown that the rays do not come from our own galaxy, so why should they come from any other galaxy? These nebulæ are of widely different types, but it seems probable that these different forms represent mainly different stages in very similar life histories. The youngest nebulæ seem to consist of a great mass of diffuse gas which gradually condenses into stars, and develops finally, in many cases, into a spiral form such as is shown by the great nebula of Andromeda. Our galaxy is probably a nebula of this last type. Thus, it is, of course, possible that the cosmic rays are produced by nebulæ in the early stages of their existence, but not in the later stages such as our galaxy is in now.

There is another reason why the cosmic rays are unlikely to be produced by the stars in ordinary nebulæ. This is the fact that the outside layers of nearly all stars are rather similar. These outside layers consist of a gaseous envelope at a temperature of, say, between 5000 and 20,000 degrees, Centigrade. Now, since we know that the sun does not produce cosmic rays, it is difficult to see why other stars, which have rather similar surface

conditions, should do so. There are exceptions to this general similarity of the outside of the stars. The white dwarfs are very small but very dense stars, and have surface conditions which are very different from that of our sun, and so might conceivably be considered possible origins for the rays. It must be remembered that cosmic rays, although very penetrating from our terrestrial standpoint in that they can penetrate some thousand meters of water, cannot be considered penetrating from the point of view of a stellar atmosphere. Any cosmic ray which was produced inside a star would never get out. It is thus clear that it is only from the outer layers of a star that the rays could come, and these outer layers are nearly all alike.

Many other possible explanations of the origin of the rays have been given, but none put forward hitherto seems very plausible. It is possible, of course, that the rays have their origin in electric fields in extra-galactic space, but there is no real reason to believe that such fields exist, and it is difficult, perhaps, to explain on this basis the isotropy of the rays. Then, Swann has suggested that they have their origin in sun-spots—not sun-spots in the Sun, of course, but postulated spots in giant stars.

Milne has predicted the existence of rays of very great energy from his cosmological theory. This theory requires also the existence of uncharged particles as well as electrically-charged particles.

Zwicky and Baade have sought the origin of the rays in the super-novæ, that once every few hundred years appear in every nebula and grow to huge intensity for a period of a few weeks. Another class of suggested origins are the archeological hypotheses. The arguments in favor of these views are roughly as follows: It is very hard to find an origin here and now in the universe for the cosmic rays, so perhaps they were formed at the very beginning of time when the world was quite young and, supposedly, very different. It is, of course, obvious that if they have come from a very great distance that they must have their origin in the distant past. Lemaitre is an exponent of one of these theories. He supposes that the rays have their origin in some kind of super-radioactive process from a single primeval nucleus, from which has developed the universe as we know it now; but, as there does not seem to be any possibility as yet of testing or distinguishing between these numerous rival hypotheses, it is probably not worth while spending very much time on such speculation. One more ingenious origin may, however, be mentioned. It has been suggested by Alfvén that the rays arise from a kind of stellar cyclotron formed by the rotation of a double star. It is supposed that the combination of an electric field of one component of the double star, together with its magnetic field, may lead to the possibility of stable orbits for high-speed electrons very similar in principle to the orbits in the cyclotron of Lawrence; but here again no definite test of this hypothesis is possible.

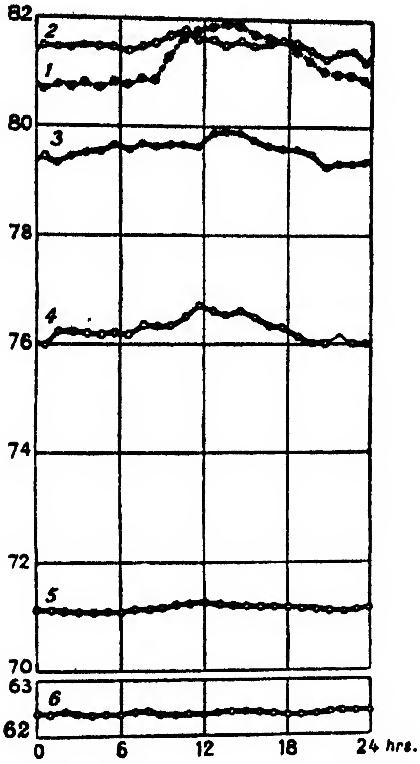


Figure 4: How the intensity (numbers at left) of cosmic radiation varies with time. Numbered curves refer to different thicknesses, respectively 0, .5, 1.5, 3, 10, and 20 centimeters of ray-absorbing lead

This is the first of three Cantor Lectures delivered before and published by The Royal Society of Arts. The remaining two lectures are not presented here because they are much more technical and mathematical. They may be obtained from the secretary of the Society, at John St., Adelphi, London, W.C. 2.

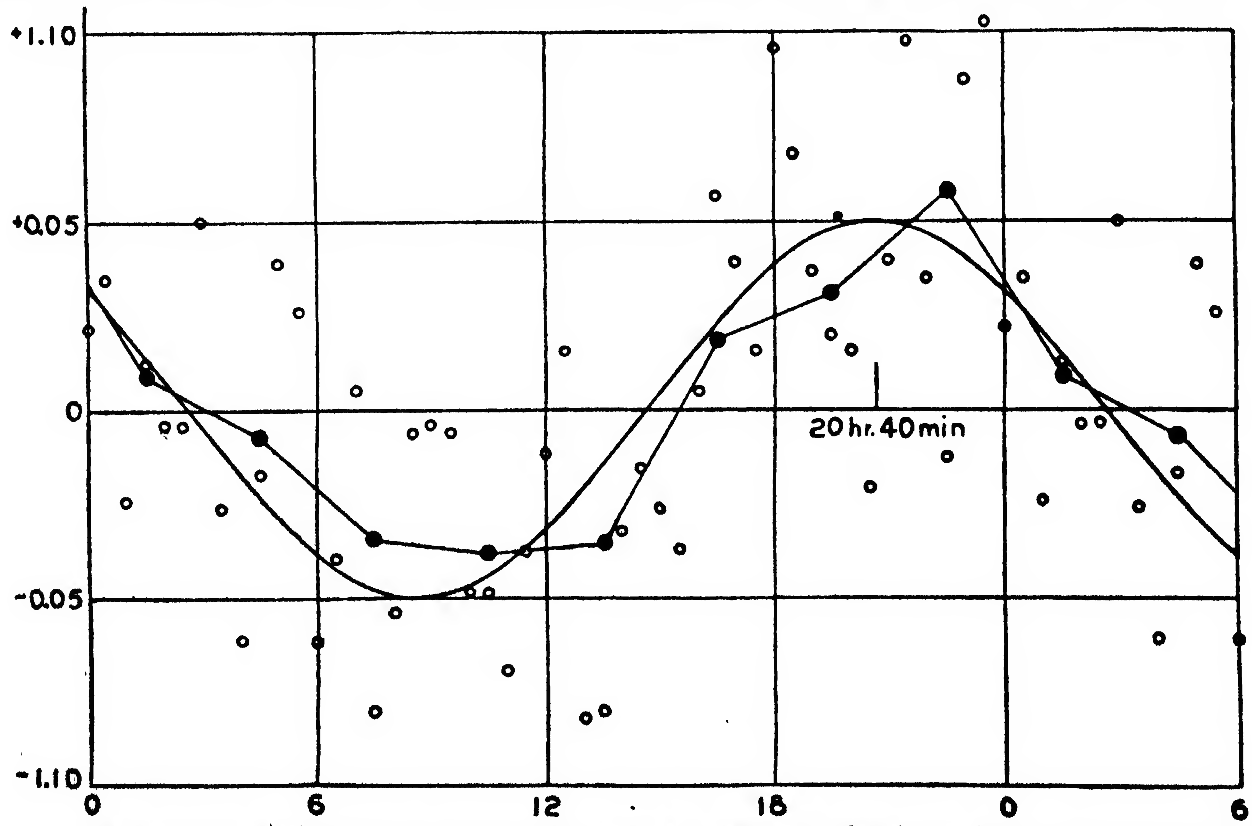


Figure 5: Percentage variation in intensity of the cosmic rays (left) with sidereal time. The smooth curve represents the predicted effect due to galactic rotation; open circles, half-hour means; solid circles, three-hour means

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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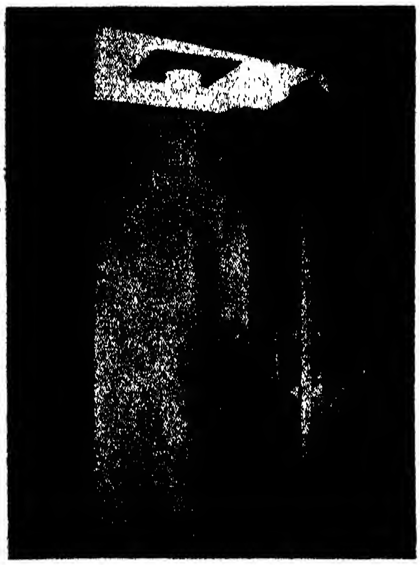
Booth Air

PROBABLY everyone who has ever used a pay telephone booth has wondered why some provision for ventilation or circulation of air is not made. To fill this need, Samson-United Corporation has adapted its rubber bladed fan for use over the telephone



Comfort for 'phone users

in such booths. An accompanying illustration shows the mounting of this fan, which is so safe that wall scribblers may push probing pencils or fingers into it without danger.

Minds Rejuvenated by Sex Hormone

OLD men can be made young again, mentally as well as sexually, by means of hormone injection, Dr. Neal E. Miller, of the Institute of Human Relations, Yale University, told a recent meeting of the American Chemical Society.

'Elation takes the place of depression in most of the patients, Dr. Miller observed in the course of an experiment in which the effect of injection of the hormone testosterone proprionate was compared with results of a similar injection not containing the hormone. The group included, in addition to the cases of old men being rejuvenated, a number who were suffering from various types of glandular deficiency. Improvement was greatest when the deficiency had been greatest. Rational aggressiveness took the place of irrational irritability, for some patients. Nervousness and emotional instability were decreased. Muscle tone, energy, and stamina returned. Emotionally and sexually the patients were in better condition.

The psychological improvement did not take place after the dose not containing the hormone.—*Science Service.*

Glass in Plastics

WOVEN glass fabric is being used to replace paper and cloth in laminating resinous insulation. The advantages claimed for the new material are lower moisture absorption, greater resistance to corrosive liquids, and better electrical characteristics. The resin used is of the phenolic type.—*D. H. K.*

Torpedo Turns Around and Goes Back to Target

A TORPEDO that does the seemingly impossible in turning around and going back after the target it has just missed has been patented by Ellison S. Purington, of Gloucester, Mass. A trailing wire contains the secret of the performance of this newly-designed underwater weapon.

If the torpedo misses the target and crosses ahead of the ship at which it is aimed, a wire trailing behind the torpedo is touched by the ship's bow, closing a contact and causing the torpedo to turn around and go back for a second try with its deadly cargo. The direction in which the torpedo will turn is determined by the direction of the ship target, a manual setting of the torpedo being made just before it is fired. Little difficulty is anticipated on this last score because of the fact that a torpedo is fired from relatively short range.

The invention is assigned to John Hays Hammond, Jr., also of Gloucester. Mr. Hammond is noted as a torpedo inventor and designer of widely-used radio equipment.—*Science Service.*

Lamps Combine Bulb and Reflector

A RADICALLY new type of Mazda lamp which includes an efficient reflector inside the bulb is announced by the Westinghouse Lamp Division of the Westinghouse Electric & Manufacturing Company.

These new lamps are made with a flared bulb, coated on the inside of the flare with metal, which takes and retains a high polish and directs the light of the filament in a powerful beam. The efficiency of the directed light is high because the reflector has the accurate shape of a modified paraboloid and the filament is precisely positioned with relation to the focal point of its reflector.

The lamps are for use primarily in show windows, but will find many other uses wherever a self-contained unit of this character is required. They are equipped with a medium screw base fitting the ordinary socket and can be installed and removed with ease, an important factor when displays are changed frequently. The lamps are rated 150 watts and are available for 110, 115, and 120 volt circuits. The rated life is 1000 hours,

Bulb and reflector combined

the same as the standard 60-watt Mazda lamp for household use. They may be used with color screens when colored light is desired. The lumen maintenance is particularly good. For many applications it is expected that these lamps will often be used with flexible adapters now on the market.

Abundance of Rare Elements

GEOPHYSICISTS have calculated that the average cubic mile of the earth's crust within 10 miles of the surface contains:

71,869,400 tons of titanium
2,966,038 tons of zirconium
456,313 tons of lithium
114,078 tons of beryllium

All that is necessary is an economical method of extracting these metals. All of them are valuable industrially but their prices are high because of the rarity of the ores from which they can be economically recovered.—*D. H. K.*

Simple Oil Tester

SINCE every motor car is operated under different conditions, the matter of oil contamination and oil change is of vital interest to the motorist. To enable the average service man to determine readily the condition of the oil in any car, a simple device has been developed by the Inspection Machinery Company. Called the Lubrimeter, this notebook-size device can be carried in the coat pocket.

The Lubrimeter is made of two small slabs of synthetic rubber (hinged together), each of which has a rectangular central window of glass. One of these windows is plain, while the other is provided with a photographic film divided into four densities for comparison with the shade of the oil in the central panel.

In testing oil, the crankcase gage stick is held over the central groove of the Lubrimeter so that a few drops of oil fall on the test glass. The device is then folded together, thus spreading the sample of oil into a thin film between the glasses. The shade of this sample is then compared with the shades of the four photographic squares. Reference to a Lubrimeter chart, considering how far the oil has been driven, will show immediately whether the oil needs changing. Viscosity may be determined by pressing a film between the two glasses and then pulling apart with a steady pressure.

Motor-car engine oil may be quickly tested for color, viscosity, and gritty contamination with this simple inexpensive device. It is easy to use

An abrasion test may be made by placing oil between the glasses and then rubbing them back and forth, gritty contamination offering resistance to this movement. After these tests, the glasses are wiped clean with a cloth and are ready to be used again.

Largest All-Welded Vessel on Great Lakes

A NEW vessel, unusual in several respects, recently completed her maiden voyage on the Great Lakes. The vessel is the *Dolomite IV*, built for Great Lakes-Barge Canal and Atlantic Coastwise Service. She is the largest all-welded vessel on the Great Lakes, according to the builders; her five storage tanks are lined with nickel; the craft was never actually launched.

This new vessel is 300 feet long, 43 feet 4 inches beam, 20 feet depth. She displaces 5500 tons light. Powered by two 750 horsepower Diesel engines, her speed is 15 miles an hour.

The hull was fabricated entirely by arc welding from rolled steel channels 18 inches wide, ½-inch web. The channels were butted against each other, flange to flange, and arc welded together both inside and out. Over 40 miles of arc welded seams were required in construction. Automatic arc welding by the "Electronic Tornado" process, using tractor type welders, was employed in fusing the main seams of the hull.

The use of nickel lining for the tanks permits rapid cleaning to accommodate different cargoes. On her maiden voyage, *Dolomite IV* unloaded her cargo of 1,200,000 gallons of kerosene one day, reloaded with wheat the next. Cleaning was accomplished by means of steam.

The launching should more properly be called a floating! The ceremony consisted simply of cracking a glass plate over the siphon in the lock in which the boat was built, thus admitting water which set the vessel afloat.

STAR

ZETA AURIGAE, the largest star in the eclipsing system, and which is equivalent to about 10 million of our suns, is as dense as the vacuum in an electric bulb.

What Fools These Mowers Be!

GRASS lawns are beautiful when perfectly kept and periodically mowed. Yet there is a tendency toward covering the lawn space with plants other than grass, and several likely ones have been developed to the point where they make superior greenswards. The *Industrial Bulletin of Arthur D. Little, Inc.* discusses this matter from the time when grass lawns on a large scale were first made possible by the development of the lawn mower and the gardening hose. That *Bulletin* then quotes an item from the magazine *Horticulture* regarding a new "turfing daisy" which seems to have many advantages over ordinary grass. This plant, *Matricaria tchihatchewi*, makes a close mat of foliage never over two inches

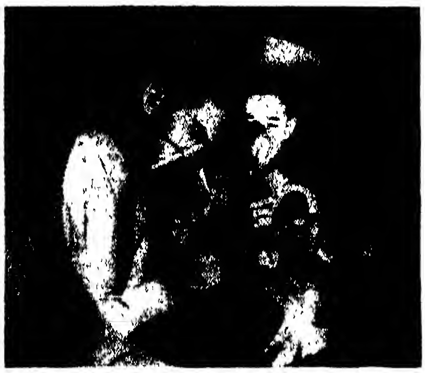
Courtesy The Lincoln Electric Company

Electric welding made possible this huge tanker for service on the Great Lakes

high, of a deep rich green color, and it grows well almost anywhere except in deep shade and in very sandy soil. The sowing should best be done in the fall or early spring. Even if the first plants come up a foot apart, the gaps will soon be closed by the creeping roots. Once a year, and once only, the daisy lawn needs cutting, in late May or early June, when the flower heads appear. No watering is needed. If this is not the dream lawn of many a long-suffering home owner, it is at least of the type and deserves consideration.

A Stratosphere Laboratory

ENGINEERS of United Air Lines now have at their disposal a stratosphere laboratory in which it will be possible to simulate atmospheric conditions existing at altitudes up to 65,000 feet. The stratosphere chamber, shown in one of our photographs,



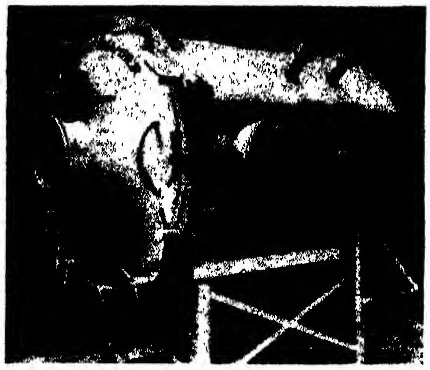
is a steel cylinder with an inside diameter of four feet and a length of five feet. Like the "bathosphere" used in under-water exploration, the heavy steel cylinder is provided with circular pressure-proof glass port-holes, located at the sides, ends, and top. These port-holes will be employed for observation of the apparatus being tested inside the cylinder. The stratosphere chamber weighs one and a half tons. The external air pressure on one of the port-holes will attain nearly 12 tons when high-altitude conditions are simulated.

Another photograph shows engineers "taking an altitude flight" and testing oxygen-inhaling apparatus. Other equipment which will be investigated will include radio apparatus, instruments of various kinds, valves for supercharged passenger cabins, and other mechanical equipment, the proper functioning of which is essential to safety in the air. —*A. K.*

Three Dimensional Weather Indicator

THE transport pilot must know the condition of the weather not only at sea-level but at varying altitudes. Now a device invented by Denis and J. Kenneth Bartlett of London, distinguished meteorologists, provides the flier with a three-dimensional weather indicator.

The instrument enables the pilot to "see" the weather not only at sea level, but at various altitudes. It is constructed of light sheets of cellulose acetate, which are transparent and non-inflammable. A six-inch cubic box is built up. On the base of the box is drawn a map of the area to be covered by the airplane. The first shelf, which is set only a few inches from the base, shows the weather conditions at ordinary sea-level; that is, barometric pressures, wind directions and magnitudes, temperatures, air mass fronts, and so on. The second shelf gives conditions at 3500 feet, and the third at 7000 feet. The top of the box represents a height of 10,000 feet. All the data can be readily sketched in and just as readily rubbed or washed off. The number of altitude shelves can be increased if required. The box is collapsible,



Above: **The stratosphere laboratory test chamber for aeronautical research. *Left:* Oxygen-inhaling apparatus being put through its paces under simulated altitude conditions**

and when not in use can be slipped into the pilot's pocket. When assembled, the device locks automatically and stands rigid. Apart from its value to pilots in actual flying, the instrument should be of great practical use in schools of meteorology and navigation. —*A. K.*

Operating Characteristics of Large Flying Boats

WE are inclined to think of a seaplane as a flying machine and its water properties as merely relating to take-off and landing. As a matter of fact, the water handling characteristics are almost equally important. In the water the flying boat must be controllable, adequately and accurately, from the moment that the securing lines are cast off until the moorings are again picked up. The pilot must at times be able to thread his way through a narrow channel with all sorts of obstructions to avoid. The hull must be directionally stable in the water, yet easy to turn without requiring bursts of power. The bigger the seaplane, the more essential are precautions when approaching moorings. The casual observer may become exasperated by the slow and deliberate approach to a mooring, but he may be equally amazed by the strain put on the snubbing posts, and temporary mooring lines, and the force with which a boat hull strikes a float or a dock if the approach has been made at a slightly optimistic speed. In addition to cutting engines at just the right speed, the pilot may have to use fully deflected flaps, water rudder, and other devices. Sailing must sometimes be resorted to, utilizing the draft of wind and water currents, alternately with short bursts of engine power.

In other words, the pilot of a flying boat is a seaman as well as a flier.

In addition to wind-tunnel models and towing-basin models, the Glenn L. Martin Company has actually built a real flying model, carrying two men, to predict the characteristics of its large designs. Such a flying model is tremendously expensive, but not as expensive as would be a mistake made in a 100,000-pound seaplane. The outcome of tests with this flying model will be awaited with intense interest.—*A. K.*

Instrument Flights

IT is interesting to learn from Paul E. Richter, Vice-President of T. W. A., that their pilots, no matter how well qualified or experienced, have to submit every 90 days to "instrument flight" tests. Placed in a covered cockpit, and flying by instruments alone, fliers must execute, perfectly, such maneuvers as instrument take-offs; spirals; 45-degree banks; 90-, 180-, and 270-degree turns; fly the radio beam and put the plane into landing position; find the airport after being deliberately "lost" by the chief pilot in charge of the tests. The cost of these tests is approximately $20,000 a year. They are well worth it since they keep flight personnel always up to standard.—*A. K.*

Propellers Rotating in Opposite Directions

TANDEM propellers rotating in opposite directions, and placed one immediately behind the other, are by no means new. According to Lieutenant H. M. McCoy of Wright Field, there is evidence of such an installation dating back to 1917. The world speed record achieved in 1934 by the Italian Macchi-Costaldi twin float Schneider Cup racer was in no slight measure due to the use of oppositely rotating propellers. The power of a 3000-horsepower engine was

One engine drives the two propellers rotating in opposite directions

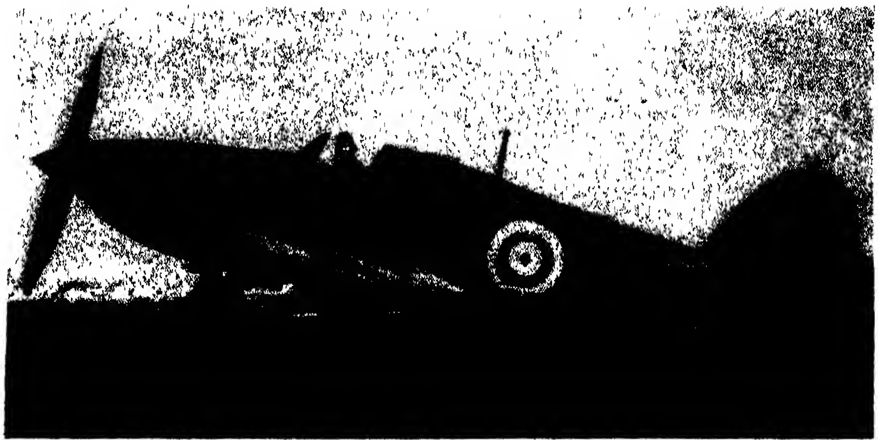
readily absorbed by the use of such a system and the speed attained was over 440 miles per hour.

It is not because the system in itself offers increased propulsive efficiency that it is coming back into favor, but because there are valuable indirect advantages. With the ordinary propeller the enormous torque of a powerful engine is difficult to counteract with ailerons and rudder, particularly on a small single-seater. And even when the torque is counteracted (as it must be for flight to be possible) there is serious loss in aerodynamic efficiency—it is obvious that

flight with ailerons and rudder displaced cannot be as efficient as normal flight with all controls in neutral. Moreover, if rudder and ailerons are counteracting the torque, the available control power is much reduced.

When a 3000-horsepower engine is to be used in a single-seater having a span of say only 30 feet, opposite rotation of airscrews driven by the same engine becomes absolutely imperative.

Our photograph shows an experimental installation on a single-seater fighter, with which the Army's Materiel Division at Dayton has carried out completely successful tests. The actual mechanism is still a matter of official secrecy. But of course everyone will guess that one propeller shaft will be hollow, that another propeller shaft will pass through the outer tube and drive the forward blades, and that gearing will be interposed between the engine and the outer tube or shaft to secure a reverse direction of rotation.—*A. K.*



Courtesy *Flight*

Hawker Hurricane single-seater fighter monoplane with Rolls-Royce Merlin engine

The Absolute Altimeter

THE altimeter is generally considered to be an instrument for indicating heights, and so it is as long as the atmosphere behaves in exact accordance with a hypothetical "standard atmosphere." But when the curve of pressure or temperature against height departs from the standard atmosphere convention, the best aircraft altimeter is no longer a reliable indicator of actual height above the ground. Many attempts have been made at absolute height indication. Sonic altimeters have been developed in which the reflection of sound waves from the earth's surface, and the time elapsed for such reflection, give indications of actual height. But the sonic altimeter has been found to be too much of a laboratory device, too little of a practical flying instrument; experiments along these lines apparently have been discontinued. Richard C. Gazeley, of the Civil Aeronautics Authority, indicates a totally different approach to the absolute altimeter.

In a paper presented before the American Society of Civil Engineers, Mr. Gazeley made the following remarks:

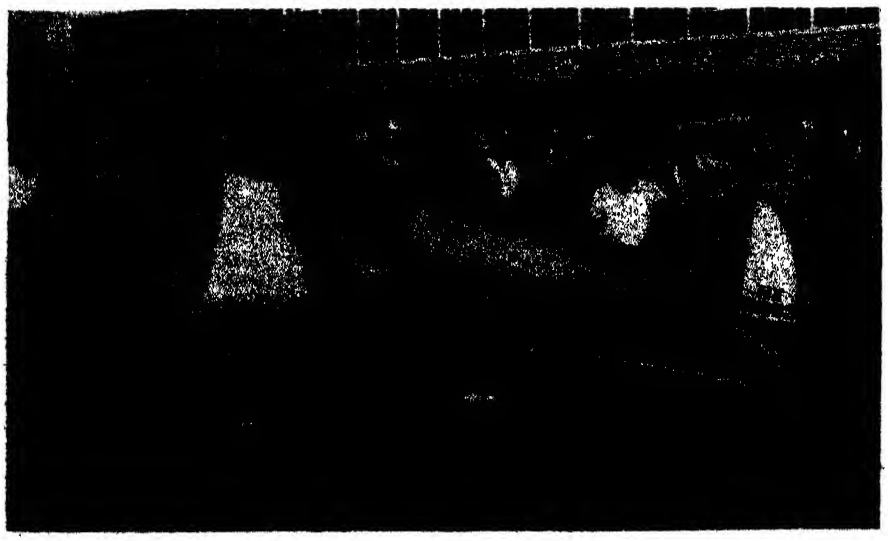
"I can foresee the development of ultra-high-frequency radio to the point where it may be utilized in an airplane to detect objects such as other aircraft in flight, mountain peaks or the varying ground elevations beneath, and indicate the distance and direction of the object from the instrument. When that day comes, we will have the collision preventer and absolute altimeter, which is one of the most wished-for developments on the part of the pilots who are accustomed to flying through clouds."

Apparently the Civil Aeronautics Authority is tackling this project of a height and object detector in earnest. Considerable secrecy surrounds the work, and we can only conjecture that the underlying principle will be akin to that of the sonic altimeter. The high-frequency radio waves will be sent out from the airplane. Encountering an obstacle—ground, mountain, or other aircraft—they will be reflected back to the airplane, where suitable delicate and intricate electrical apparatus—radio receiver and oscillograph, perhaps—will indicate the reflected waves. From such indications, suitable calibration will give a measurement of the distance between airplane and the solid object, the position of which is being determined. While we do not envy the research workers the difficulties of their task, we certainly wish them the speediest success.—*A. K.*

Busman's Holiday

NO one has ever heard of the employees of a shoe factory banding together to build shoes on their own time, but the construction of new types of aircraft is so fascinating an activity that men whose vocation lies in the construction or development of aircraft, will take a long busman's holiday and devote the major portion of their leisure hours to the construction of a novel design of airplane. Thus our readers will perhaps remember that the young engineers of the N.A.C.A. laboratory at Langley Field, under the leadership of Fred Weick, built a light plane with a nose-wheel or "tricycle" type landing gear, and this type of gear has now been quite widely adopted.

Now we hear that the employees of Consolidated Aircraft Corporation have formed an Aircraft Mechanics Association, and instead of plotting strikes or joining the C.I.O., the Association has designed and built a very trim and workmanlike light plane, which is shown in our photograph. While the new ship is designed on the conventional lines of a low-wing single-seater, it shows excellent streamlining, good structure, and a simplicity which will help if the ship is ever put on the market. Equipped with a 40 horsepower Continental engine, carrying fuel for 400 miles, and 20 pounds of baggage, the machine attained a top speed of 94 miles per hour—a highly satisfactory figure for such a craft.—*A. K.*



Fine results of a busman's holiday

Are Fighters too Fast?

THE Hawker Hurricane single-seater fighter is in rapid production for the British Royal Air Force and is one of the best known airplanes in the world. A Hurricane machine recently accomplished a spectacular night flight of 327 miles in 48 minutes, at the average speed of 408.75 miles per hour. It is probable that a favorable tail wind helped in this achievement. Nevertheless, the Hurricane is undoubtedly one of the two or three fastest airplanes in service anywhere. The maximum speed is given as 335 miles an hour, but there is a shrewd suspicion that, in the latest versions of this fast machine, speeds in excess of 350 miles have been attained. Landing speed is 60 miles an hour, so that the speed range has the remarkable value of approximately 6 to 1. The time to climb to 15,000 feet is only six minutes.

Endurance is only two to four hours, and this is low according to American practice. But the Hawker Hurricane is an intercepter fighter and there are only short distances between England's coast and the city of London. As a compensation, there is a plenitude of guns, with eight Browning machine guns, four in each wing, fired by remote control, and without the interrupter gear which is used when firing through the propeller.

Courtesy Lincoln Electric Company

Minimum size pressure gas holder, with maximum capacity

But, strangely enough, there are some indications that military designers the world over have perhaps gone too far in seeking speed and in adopting the extremely clean, long span, and large over-all dimensions of the monoplane in place of the more concentrated, though slower, biplane. In gaining enormous speed, the fighting ships have lost maneuverability, and with loss of maneuverability there is loss of the ability to take care of oneself in an aerial dog fight.

Reports from Spain have it that obsolete English biplanes in the hands of the Loyalists, with unsupercharged engines, have played havoc with the enormously speedy German Heinkels and Italian Fiats, supercharged for high-altitude work, available to the Insurgents. It was one of the biggest surprises of the war that Loyalists, apparently outclassed, refusing unchivalrously to fight at great altitudes, shot down their opponents again and again by virtue of greater maneuverability.

A highly qualified American engineer, now building airplanes in China, who has observed many aerial combats between the Chinese and the Japanese, gives us a similar account of the actual tactical superiority of the slower biplane. The high-speed monoplane swoops, fires, and runs. The biplane can dive, flatten out, roll, loop, and perform other military acrobatics with complete disregard of load factors, and as a result actually wins the fight!

It is to be hoped that our own Army Air Corps is making observations and deductions from these reports of the Spanish and Sino-Japanese aerial warfare.—*A. K.*

Combustible Sewage Gas Stored in New Type Holder

A PRESSURE gas holder, a comparatively new type for storing gases generated by decomposition of sewage, has been completed at the Cuyahoga Heights southerly plant of the $14,000,000 sewage disposal project of Cleveland, Ohio.

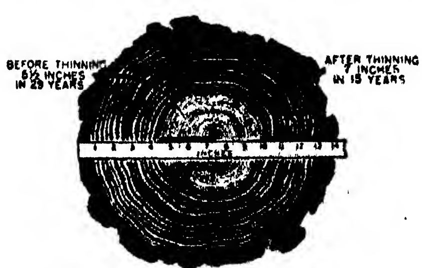
The holder is a 57½-foot diameter, arc-welded sphere having a capacity of 200,000 cubic feet of free gas at 29 pounds operating pressure. The design and method of construction made it possible to obtain the required capacity in a structure which is considerably smaller than would be the case with other types of holders. The smaller size provides savings, not only in initial cost, but also in operating costs, since there are no moving parts. Maintenance costs are expected to be negligible.

The purpose of the holder is to store gas produced in excess of normal consumption and to pay out deficiencies as required. The sphere floats on the line in much the same manner as an elevated tank in a water system. The surplus gas in the sphere will be compressed and paid out into the service lines as needed for laboratory, boilers, and two 400-horsepower gas engines. Generation of gas from sewage is by natural decomposition, accelerated by controlled digestive elements.

The designers of the disposal project, George B. Gascoigne and associates, Cleveland, liken the sphere's form to a bubble, nature's example of a structure having uniform stress in every part.

Thinning Speeds Tree Growth

TREES in overcrowded stands grow slowly. Thinning them out pays, as does thinning of cotton or corn. The accompanying illustration shows a cross section of a



How thinning speeds tree growth

crowded pine that grew to only 5½ inches in diameter in 29 years. After the stand was thinned, growth stepped up to increase the diameter seven inches in only 15 years. After thinning of the forest in which it grew, the tree grew about three times as fast as before.

New pulp and paper mills in the south are creating new markets for wood. Pulp mills require a steady and constant supply of pulpwood. A constant market makes it more practical to cut for steady profit, says Wilbur R. Mattoon, Extension Forester of the United States Department of Agriculture. Trees are the capital in the farmer's woodland bank, he says. If the timber is cut only to the extent that the growth has increased since the previous cutting, the woods' capital remains unimpaired and continues as a paying investment.

SCIENCE TALKS

THE number of scientific papers (reports) published in a year throughout the world has been estimated to amount to three quarters of a million.—*Nature* (London).

Acetylene Paint-Burner

IN removing paint with an ordinary blowtorch, considerable soot is deposited on the woodwork and the flame itself is none too efficient. The Linde Air Products Company has developed an air-acetylene paint-burner to supplant the older process. It is

Paint burning with gas flame

said to be one of the fastest known methods for removing paint and far superior to the use of chemical removers. The flame, flattened out in a brush-like shape, is of an even, high temperature throughout. It is not easily blown out by wind and is under such close control that the danger of burning spots on wood or canvas is eliminated. With it, many coats of paint can be removed in one operation.

Why Athletes Rest Before a Competition

IN a paper contributed to the recent British Medical Association meeting, Prof. E. P. Cathcart of Glasgow discussed the various factors that go to form the basis of physical fitness. It will not be achieved merely by

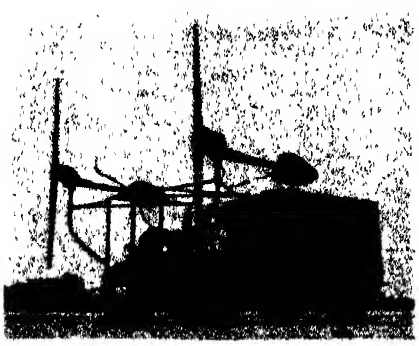
satisfaction of the needs of the body, for malnutrition of the spirit is quite as common as malnutrition of the body, and the one reacts upon the other. There is evidence that meat is not essential, and perfect fitness may be acquired on a diet of brown bread, milk, butter, cheese, fresh fruit and salad, provided it is adequate. For heavy work, fat appears to be an important source of energy. Sugar and carbohydrates are known to be important sources of energy; but apparently are not immediately available, but have first to be converted into glycogen, so that Krogh and others suggest that in sporting events the athlete should have two days' rest before the contest to secure a complete filling up of the glycogen stores of the body.—*Nature* (London).

Wind-Charger Test Truck

W. G. DUNN, pioneer wind-electric engineer and inventor, has added a truck testing unit to the experimental equipment of the Parris-Dunn Corporation. This 1½ ton truck is designed and outfitted exclusively for wind-electric experimental work.

The unique arrangement permits the experimental department to obtain accurate comparative readings on any two wind electric units while operating under identical wind conditions created by the movement of the truck.

Our photograph shows how the mounting standards open out from the truck for comparative experimental test runs. The gooseneck standard that appears in the center is a supersensitive velometer for determining the exact wind velocity under which the wind-electric equipment is operating. The mounting standards fold back beside the truck to comply with all highway laws while in transit between factory and proving grounds.



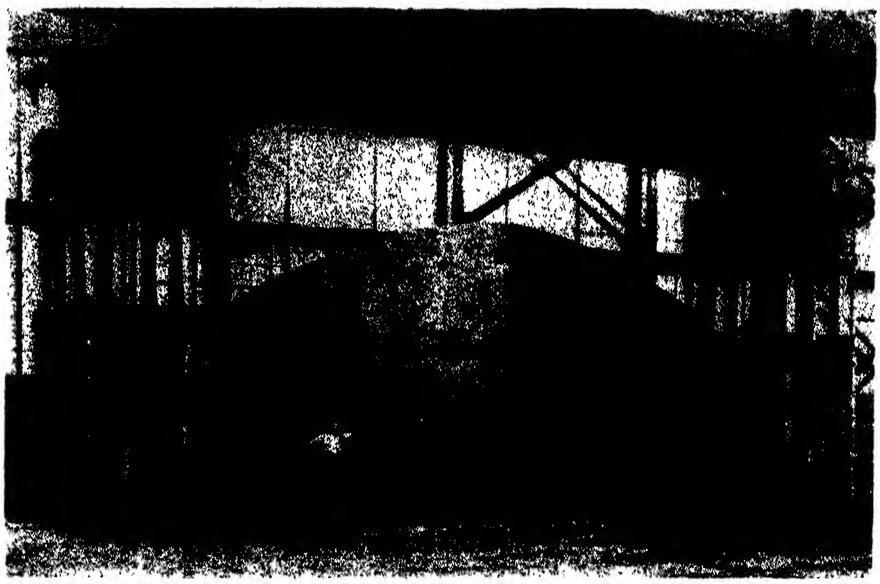
Wind-chargers on test

On the inside of the panel body are two complete instrument panels consisting of master ammeters, voltage gages, relay cut-outs, and the like, as well as the velometer dial for accurate wind-speed readings.

Huge Bending Press

WHAT is believed to be the largest bending press in the world, both as to size and capacity, has recently been built by the Baldwin-Southwark Corporation. Of 6000 tons capacity, it will handle plates up to 40 feet in length and 8 inches thick, and bend them into semi-circular shapes for high-pressure steel drums.

The bending press consists of two specially designed vertical presses of 3000 tons capacity each. These presses are connected by bending beams 52 feet long which are made of plate steel construction, 15 feet deep and 20 inches thick.



Steel plates eight inches thick can be bent in this press

While only the top beam is visible in the photograph, a similarly constructed bottom bending beam is below the foundation line. This bottom beam rests on the cast-steel bottom platen of each press.

Weight of the material entering into the construction of these two beams is approximately 1,000,000 pounds, while the weight of the two presses, together with accessories, is also approximately 1,000,000 pounds, thus making the total weight of the machine about 2,000,000 pounds.

Unique features in the design of this press are the equalizing arrangement of the pressure on both main cylinders to take eccentric loading and, also, the special swiveling and thrust-block arrangement on the moving beam. This latter arrangement permits the eccentric loading without throwing any side strains on either press.

HOLES

ELECTRIC eyes now keep holes out of tin cans. Installed in a steel mill, a bank of photoelectric cells keeps watch on the thin sheet of steel as it races 700 feet a minute on its way to become tin cans. An article in *The Electric Journal* reports that these "eyes" not only see tiny pin point holes as small as one sixty-fourth of an inch across but they also operate a device to mark each hole.

Heating Hot-Water Bags Electrically

IT is claimed that electric heating pads are inferior to hot-water bottles in certain respects and that hospitals generally favor the use of the latter. Hot-water bottles, however, ordinarily require a great deal of attention in the constant refilling that is necessary. The Thermo Electric Products Company has eliminated this inconvenience by developing an electric heating unit which may be screwed into the neck of the bag in place of the ordinary screw stopper.

In the upper part of this unit there is a thermostat made of laminated steel with silver points, which maintains the heat at a pre-determined point. The heating element which protrudes inside the bag is enclosed in a moisture-resisting Bakelite shell which is provided with holes for the penetration of water. Water in the bag makes the final electrical contact so that, even though the current is turned on, the unit does not heat unless there is water present to close the circuit. The whole unit is so enclosed that there is no possibility of the patient receiving a shock at any time. Since the heat is at all times lower than boiling, no steam can be formed. The unit is made to operate only on alternating current.

Constant heat for hot-water bottle

The manufacturers claim that this unit is sufficiently rugged to last for years, and claim further that in continuous use for weeks at a time its action has been safe and efficient.

Advertising Costs

TO contradict the prevalent fallacy that advertising is a wasteful process and that the consumer pays the disproportionate bill, the National Better Business Bureau, Inc. has published some interesting statistics in a new bulletin.

For example, the Bureau says, the advertising expense on a nationally adver-

tised bed sheet that retails for $1.75 is exactly one cent. The advertising expenditure on a loaf of bread is less than the cost of the wrapper that keeps it clean. The manufacturer of a well-known soap costing seven cents a cake uses just 1/5 of 1 cent per cake to advertise it. The cost of advertising a 12-cent can of soup is 36/1000 of 1 cent.

Oil Under the Mississippi

OIL deposits directly underneath the bed of the Mississippi River were successfully opened recently when Continental Oil Company brought in a flow estimated at 204 barrels a day in St. James Parish near

Site of the oil well that has tapped deposits under the Mississippi

Vacherie, Louisiana, through the first well ever drilled inside the river levee.

The discovery well, known as Realty Operators No. 1, is located on the eastern side of the river about 55 miles northwest of New Orleans at a point where the bottom ground or "batture" between river and levee is about 1600 feet wide. Protection from possible flooding of the well site required the building of a separate circular levee 14 feet high, inside the main levee.

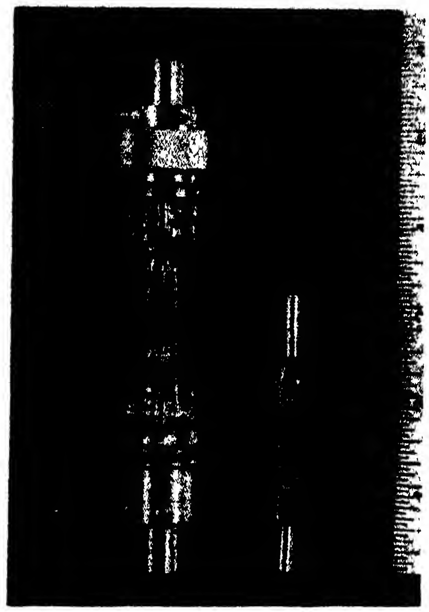
Continental officials revealed that 40 foot pilings had to be sunk in the swampy soil to support the drilling rig and that equipment was brought over on a specially constructed plank road.

The well was reported producing a 43.2 gravity crude through tubing perforated from 6358 to 6364 feet, with a tubing pressure of 2350 pounds. The well was drilled to a total depth of 7499 feet, but plugged back to 6364 feet to a sand laid down in the Miocene Age. The well is also producing 4,131,000 cubic feet of gas daily. The new field is known as the Hester Dome area, where Continental and Shell have about 10,000 acres under lease.

"Midget Sun" Electric Light

A MIDGET sun in the form of a 1000-watt mercury lamp, no larger than a cigarette yet designed to attain a brilliancy equivalent to about one fifth that of the sun's surface, was announced recently by the Incandescent Lamp Department of General Electric Company.

Since the light source, an arc, is highly concentrated and is approximately 12 times



Mounted and unmounted "midget sun" lamps, compared with a ruler

as brilliant as the incandescent filament of a 1000-watt standard projection lamp, G.E. engineers believe the water-cooled midget sun will revolutionize lighting practice in numerous fields of light projection. Results of numerous laboratory tests indicate that the new lamp can be used to great advantage in photo-engraving work, in blueprinting, photo-enlarging, in searchlights, and for therapeutic application.

The new lamp consists of a small quartz tube. Confined within a tiny bore inside the tube is a globule of mercury and a trace of argon gas. Each end of the quartz tube is furnished with a brass ferrule which provides electrical contact.

In producing so brilliant a light, the midget sun develops such high pressure and heat as to destroy itself unless the lamp is properly water-cooled. By developing an ingenious water-cooling jacket, which permits three quarts of water per minute to flow past the gleaming mercury lamp, engineers found a practical way to carry off the excess heat without affecting the light output. The cylindrical glass portion of the water jacket is about the size of a shotgun shell. A small screw adjustment at one end of the jacket permits easy insertion and removal of the quartz lamp. Metal connections for water intake and outlet are located at each end of this water-cooling accessory.

The brilliant light produced by the quartz capillary lamp emanates from a narrow arc stream not much wider or longer than a common pin. Compared with the bluish light emitted by conventional mercury lamps, radiation from the new 1000-watt source is much whiter.

When the water jacket is made of quartz instead of hard glass, the unit emits a wealth of ultra-violet radiation. Special glass that screens out dangerous ultra-violet rays not found in natural sunlight at earth levels may be used instead of quartz, G.E. engineers said. Although the water in the jacket absorbs approximately 90 percent of the heat generated, it allows practically all the ultra-violet and visible radiation to reach the outer envelope.

HEAT

SINCE the earth's air weighs 11,850 million millions of pounds, all the heat produced in factories, homes, vehicles, and so forth, increases the temperature of our atmosphere only 1/54 of one degree.

Combating Banana Disease

A DISEASE threatening the banana plantations of Central America is being checked by the copious use of Bordeaux mixture as a spray. This mixture consists of five pounds of copper sulfate and five pounds of lime in 50 gallons of water. To preserve the plants, applications of 250 to 300 gallons per acre are required at 15-day intervals. As many as 18 applications per season are necessary. The residue left on the fruit must be washed off first with dilute hydrochloric acid and then with water before shipment. The disease, known as sigatoka, which attacks the leaves of the plants, is effectively stopped by this treatment.

—*D. H. K.*

Safe Faucet Handles

LAST year after one of the editors of this magazine suffered a serious cut on his thumb—which severed nerves and a small artery—we asked in this department why molded resin faucet handles could not be made available. Too many similar accidents caused by the breaking of porcelain handles under pressure have happened throughout

For safety in the home

the country. To eliminate this danger the Boonton Molding Company has molded in black Bakelite a faucet handle which is both attractive and permanently safe. It will not break under severest use.

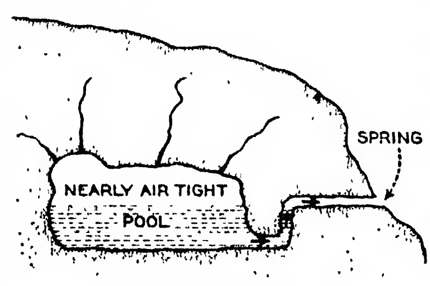
Mysterious Springs—Dry Weather Type

NOW and then a reader of this magazine describes and inquires for the explanation of a type of intermittent spring called dry weather springs. From an article on intermittent springs, in the *Monthly Weather Review* (United States Weather Bureau, Washington, D. C.), written by the meteoro-

logical physicist, Prof. W. J. Humphreys, we quote the following lucid explanation of this puzzling type of spring:

"Especially in limestone regions, an occasional spring that has become nearly, or even quite, dry starts flowing again or flowing more strongly on the approach of a general rain, hours before a drop of water has fallen within many miles of its place. Sometimes, though relatively rarely, very little rain, or even no rain, falls in the region of the spring for days, or perhaps weeks, after the flow begins; in which case the spring promptly dries up again. Marked fluctuations of this kind are distinctly drought phenomena; they do not occur when rains are frequent enough to maintain a goodly supply of ground-water.

"Their explanation is simple: The channel to such a spring leads to a cavity (see the accompanying drawing) which, during



A dry-weather spring

a prolonged dry spell when the seepage into it is becoming less and less, gradually empties, slowly filling the while with infiltered air, until the water pressure at the reservoir outlet, below the surface, is no longer sufficient to force an outflow.

"If, now, the pressure of the open air should be lowered while that of the rather closely entrapped air in the half-emptied underground reservoir is unchanged, water would be forced out from the place of the greater to that of the lesser pressure, that is, from the half-filled cavity to the open spring. Now a marked decrease of atmospheric pressure is just what happens at the approach of a general rain, often beginning hours ahead of the precipitation; and, as early, causing certain springs to run again in the midst of a drought, or to run more freely if not yet dry—a mysterious flow, prophetic of rain."

The Food, Drug, and Cosmetic Act

The Food, Drug, and Cosmetic Act of 1938 has been signed. This is a law of far-reaching importance to every person in the United States. It is a revision of the Food and Drug Acts of 1906, and greatly strengthens the protection given the health and the purses of consumers. It will stand as a legislative monument to the memory of the late Senator Royal S. Copeland of New York who worked unremittingly for a really effective measure.

The differences between the new law and the old are many. A few of the more important are as follows:

The new law brings *all cosmetics* except toilet soaps under control, and outlaws those which may be injurious to health.

It brings under control drugs used in the diagnosis of disease, and drugs intended to

affect the structure or any function of the body. Reducing drugs, so-called "slenderizers," are included in this provision.

The new law prohibits traffic in *new* drugs, unless such drugs have been adequately tested to show they are safe for use, and requires that certain habit-forming drugs bear warning labels.

It includes therapeutic devices and will afford protection against the sale of such fake contraptions as so-called "electric" belts.

It provides for definitions and standards of identity and quality for food under which the integrity of our food supplies can be maintained.

It sets up more effective safeguards against poisonous foods.

It provides increased criminal penalties for violations.

While the *general* provisions of the law become effective a year from the date of signature, certain provisions affecting the public health became effective when the President signed the bill.

Those provisions include the prohibition against drugs which are dangerous to the consumer when used as prescribed on the label, and against cosmetics which may be injurious to the user.

However, let me say that under the new law, as under the old law, the consumer who wishes to avail himself of the maximum protection afforded by the operation of enforcement will have to make some study of the meaning of statements that appear on the labels of foods, drugs, and cosmetics. The old Act forbade certain types of statements on labels. It contained few positive requirements for labeling. The new Act requires much information of value to consumers to appear on the packages in which we buy foods, drugs, and cosmetics. It is still up to the consumer to find out what this significant information means to him and his family, and to apply that knowledge in his buying.—*From a radio talk by Henry A. Wallace, Secretary of Agriculture.*

FINGERPRINTS

IT has been estimated that fingerprints may be duplicated once in 1,606,937,974,174,171,729,761,809,705,564,167,968,221,676,069,604,401,795,301,376 times! Or, we might say, a particular fingerprint will be repeated in about 2800 years!

CALCIUM METAPHOSPHATE FERTILIZERS

HIGH concentration phosphatic fertilizers have been among the prime objectives of the Tennessee Valley Authority development at Muscle Shoals, Alabama. Among the fertilizers made is calcium metaphosphate, containing 60 to 70 percent phosphoric acid (P_2O_5), of which 99 percent is available to plants. This material compares with ordinary phosphate containing 16 to 20 percent available phosphoric acid and the more concentrated triple superphosphates having 48 to 50 percent available phosphoric acid.

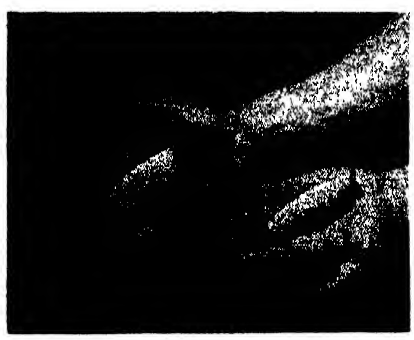
Calcium metaphosphate as manufactured is a transparent glass colored by the impurities present. It is slowly soluble in water and in

the soil solution when ground for use. The method of its manufacture utilizes phosphorus pentoxide produced by burning phosphorus. The hot fumes from the burning of phosphorus are conducted through a bed of phosphate rock in a kiln resembling a lime kiln. By proper regulation of temperature, the metaphosphate melts and runs out of the bottom of the furnace. The potential value of this method of converting phosphate rock into fertilizer lies in the fact that the element phosphorus, itself, can now be shipped in tank cars to the place where exist the rock deposits for the treatment. The high concentration of metaphosphate fertilizer makes it more economical to ship than other forms of phosphate fertilizer.—*D. H. K.*

Porcelain Lures

VERSATILE porcelain enamel is invading the realm of sport. The Porcelure Fishing Equipment Company has announced a new kind of trolling spoon made of Armco enameling iron with a fused coating of gleaming porcelain enamel.

Known to the sporting goods trade as Porcelure, the spoons come in four sizes and are colored to represent sardines, gold fish, and white red-heads. Because of the durability and luster of the porcelain enamel, the manufacturers guarantee the spoons against scratching, fading, or tarnishing. The spoons are said to have a stunned fish action calculated to whet the appetites of game fish. The eyes always gleam and the scales glitter, whether the spoons are used in fresh water or salt.



Fish foolers

Improved Reading Technique

AN increase of nearly 44 percent in reading speed and 10 percent in reading comprehension through use of a new corrective reading technique has been reported by E. A. Taylor of the American Optical Company's bureau of visual science.

Subjects undergoing the training ranged in age from 14 to 65 years, and age did not hinder improvement of reading habits, he stated.

As reported, reading speed jumped from an average of 256.20 words per minute to 368.80, a gain of 43.90 percent, after 13.16 20-minute periods of reading training. In every case there was an increase in reading speed.

Average comprehension of what was read jumped from 77 percent to 84.50 percent, an increase of 9.74 percent. Regressive movements during reading decreased 37.11 percent, fixations decreased 20.14 percent,

and eye discomfort, present in most cases, was relieved.

Scientific equipment used consisted of the Metron-O-Scope, an instrument designed to control reading patterns, and the Ophthalm-O-Graph, an instrument which photographs eye movements in the act of reading.

Scorpions More Dangerous than Rattlers

SCORPIONS are not to be regarded lightly, declares H. L. Stahnke of Mesa Union High School, in *Science*. "More lives have been lost in Arizona from the sting of the scorpion than from the bite or sting of any other venomous arthropod or reptile, at least during the nine-year period since 1929," he writes. "For a period of six and one half years, beginning with 1929, there were recorded 25 deaths resulting from the sting of the scorpion and only 10 deaths caused by the rattlesnake, gila monster, and other poisonous animals.

"Most of the deaths due to scorpion sting have occurred in the southern part of the state, particularly in the Salt River Valley, and the victims have been children usually six years of age and under. The writer knows of one case in which an eight-year-old child succumbed to a scorpion sting."

The Mexican government's Institute of Health donated two ampullae of anti-scorpion serum, Mr. Stahnke states, adding: "In all cases it has proved entirely effective, and no deaths have resulted from scorpion sting, even though the serum was used in quite advanced stages of poisoning."—*Science Service.*

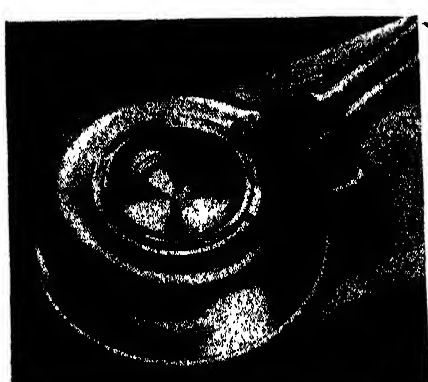
Rayon from Reeds

CELLULOSE now being made in Manchuria from reeds is reported to have a higher content of alpha cellulose than that made from wood pulp. The Japanese are using this pulp in the manufacture of rayon.—*D. H. K.*

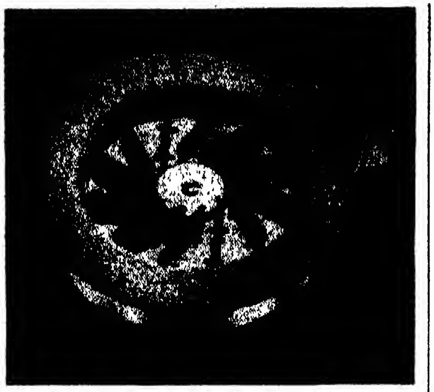
Floor Polisher Uses Air Pressure

OPERATED by the air pressure developed by the Eureka Vacuum Cleaner, the new inexpensive Eureka Power Polisher makes child's play of floor polishing.

Housed in a die-cast aluminum case, the floor brush is rotated by the die-cast alumi-



Vacuum cleaner powered polisher



Under side of floor polisher, showing the rotating polishing brushes

num turbine mounted on its back. The turbine is connected to the bag-fitting of the vacuum cleaner by a flexible hose and hollow aluminum alloy handle.

The housewife disconnects the bag from the vacuum cleaner, attaches the polisher hose, starts the cleaner motor, and lets air pressure do the work. The light weight of the aluminum polisher makes its operation easy for the woman of the house, and enables her to move the machine anywhere in the house without back-breaking effort.

Synthetic Drying Oils

NEW types of drying oils have lately been developed which are derived from animal fats by synthetic processes. The new oils are said to be cheap and to possess remarkably good properties for use in paint and varnish films. The films formed from them possess remarkable flexibility and toughness.—*D. H. K.*

"Zippers" Electroplated and Colored

MANUFACTURERS of textile, leather, and other products which use "zippers" in their construction will be interested to know that metallic "zippers" are now obtainable in plated, lacquered, and colored finishes to harmonize with the design of the merchandise with which they are used. This development is a product of the Hanson-Van Winkle-Munning Company, manufacturers of electroplating equipment and supplies, who have developed a machine which automatically and continuously plates the "zippers."

This machine is essentially a conveyor mechanism which handles the "zippers" in the tapes on which they are shipped. The principle of the machine is simple. It draws the tape through the various tanks, cleaners, plating solutions, rinsers, in regular order.

Each Family Has 400 Mechanical Slaves

"MORE power to you" is no idle toast but a prediction to Dean A. A. Potter of Purdue University who foresees more and more power being used in future years to promote general well-being. More comfortable living due to air-conditioning, electrical gadgets in home and business, and other improved mechanical devices will require more power in the near future, he says.

Each of America's 30,000,000 families has

The Editors Recommend

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6. THE ART AND SCIENCE OF MARRIAGE—*By Esther B. Tietz, M.D., Ph.D., and Charles K. Weichert, Ph.D.*
A well-balanced, authoritative study of the body and its functions, including the reproductive system, and a practical discussion of courtship and marriage. Recommended especially for engaged couples.—$2.65 postpaid.

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Fundamental principles of air conditioning. Various kinds of equipment and what each will do, and how the equipment is installed and operated.—$3.20 postpaid.

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An authoritative account of sailing craft by experts. Chapters on boat designing, catboats, racing scows, 15- and 20-foot sneaks, Wee Scots, models and the sailing of models, etc. A book for everyone who likes boats, sails boats, or owns a boat.—Illustrated.—(Formerly $12.00.)—$2.75 postpaid.

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the mechanical equivalent of more than 400 human slaves available day and night, Dean Potter reminded the scientists. This means 10 horsepower for each person or more than 1⅓ billion horsepower in all.

The bulk of America's power will continue to come from coal as it does now, Dean Potter states. Stationary coal-burning steam-electric power plants now produce electricity at a cost of four to six tenths of a cent per kilowatt-hour.

Research to solve the power problems of the future was urged by Dean Potter. For instance, now it is cheaper to haul coal 900 miles than to transmit electrical power 200 miles. The steam locomotive is to remain the main source of power for railways, although electric and Diesel locomotives will find larger use. Now electric locomotives are only 2 percent of those in use and internal combustion engines less than one half of one percent.

Trucks, buses, and tractors will use more engines of the Diesel type, Dean Potter predicted, while passenger autos are destined to be safer, more economical, and more powerful.—*Science Service.*

Thousands of Women are Duped

THE feminine side of the birth control business is appalling. Women spend 200,000,000 dollars yearly for millions of devices, instruments, jellies, powders, and liquids, totaling at least 636 different brands, sold largely under the deceptive advertising term "Feminine Hygiene." Not one of them has been proved to be entirely effective when used alone, and some of them are potentially dangerous. Physicians have asserted that not one of the products thus advertised cures or prevents venereal disease and that the normal female organs have no need for such hygiene. In fact, too frequent attempts at cleansing may even cause inflammation. Some of the numerous feminine products may not be harmful in themselves. Nevertheless they may cause incalculable harm when advertised under a slogan that the public understands to mean contraception. "Feminine hygiene" products may even be advertised as "sure, safe, and dependable," but where the advertiser means "sure, safe and dependable for feminine hygiene" the purchaser interprets it to mean sure, safe and dependable for contraception. Perhaps only physicians know that no "feminine hygiene" products are "sure, safe and dependable" contraceptives. The result of such advertising is that thousands of women are duped. There is not one product on the market that is 100 percent efficient as a contraceptive measure. —*Journal of the American Medical Association.*

Electrical Baby Blanket

THOSE who remember General Electric's development of an electrically heated bed sheet, which had the virtue of supplying sufficient heat under absolute control without the burdensome weight of heavy bed covering, will be interested in a new baby crib blanket constructed along the same lines. This blanket is fully automatic, in that it adapts itself to changing weather

conditions during the night and maintains a pre-set temperature level. Despite the wiring contained in its double thickness, it can be laundered easily and it is shockproof when wet. It is connected to the ordinary household circuit of 115 volts but a transformer reduces this voltage to 18, a voltage which is not even strong enough to provide a tingling sensation when passed through any part of the body.

STEAM

A PASSENGER locomotive uses from 70 to 120 gallons of water per mile; a freight locomotive uses from 150 to 350 gallons for the same distance.

Wool-Like Fiber From Skim Milk

A SYNTHETIC fiber having the appearance of wool can be manufactured from casein, a milk by-product, by a process devised by Stephen P. Gould and Earl O. Whittier of the Bureau of Dairy Industry, United States Department of Agriculture. The process is similar to that used in making viscose rayon from cellulose, and public service patents, applied for by the Bureau, are pending.

In Italy, where a somewhat different process for making casein fiber was announced three years ago, production is already on a commercial scale. Most of the fabrics, however, are half synthetic and half wool.

To make the fiber, casein is softened in water and dissolved in a solution of caustic alkali. It becomes a thick, sticky mass and is carefully worked into the proper consistency by aging, addition of modifying agents, and dilution. The mass is then forced through multiple spinnerets of the kind used in making rayon. The fibers are separated and hardened in an acid bath containing formaldehyde and modifiers.

Synthetic fiber produced in this manner has a chemical composition almost identical with wool except for a lower sulfur content. The fiber is faintly yellow in color and closely resembles best grade, thoroughly washed and carded, Merino wool, the finest size marketed. The casein fiber has the characteristic fine kink of natural wool and may be blended with it to make a product that has the resilience of pure wool. Synthetic fibers with this kinky structure have been made from plant materials recently, but they do not take wool dyes.

• Because the fibers are smooth, rather than scaly like natural wool fibers, they cannot be felted. For the same reason, however, the synthetic fiber does not shrink as much as wool. By varying the acid bath in manufacture, the fiber may be made either soft or harsh to the touch. The softer grades, while not as strong, make up into knitted garments which may be worn next to a sensitive skin which cannot tolerate knitted wool.

Because casein fiber has been produced in this country only on an experimental basis, commercial costs have not been definitely determined. Gould and Whittier believe, however, that it can be manufactured to be sold at a price on par with that of rayon, which is about 50 cents a pound.

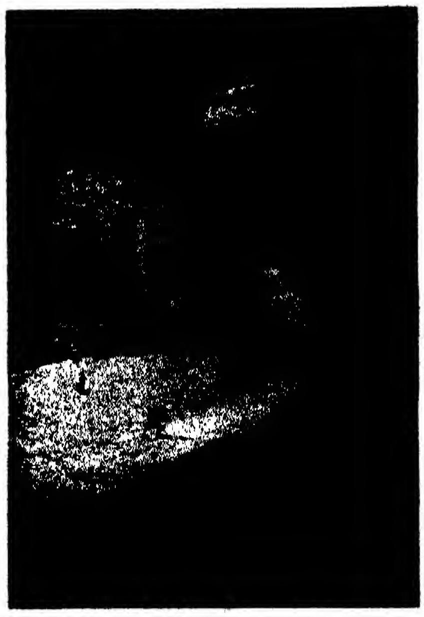
Conducted by **JACOB DESCHIN**

Seeing Double

UPON the simple fact that one eye sees a different aspect of the same subject than the other, is based the fascinating art of stereo photography, now slowly returning to favor after a long neglect. Various experiments may be employed to illustrate this, as by holding an object at arm's length and observing the subject first with one eye and then with the other. The subject will appear slightly different in each case. By using both eyes at the same time a single image of natural solidity is seen.

The stereo camera in essence is simply two cameras in one box, divided by a partition in the center. Each "camera" has its own lens, diaphragm, and shutter and the pictures are taken side by side on a single film or plate. The lenses are identical and, imitating the separation of the eyes, are placed about 2½ inches apart. As with human vision, the image recorded by one of the camera lenses is slightly different from the other.

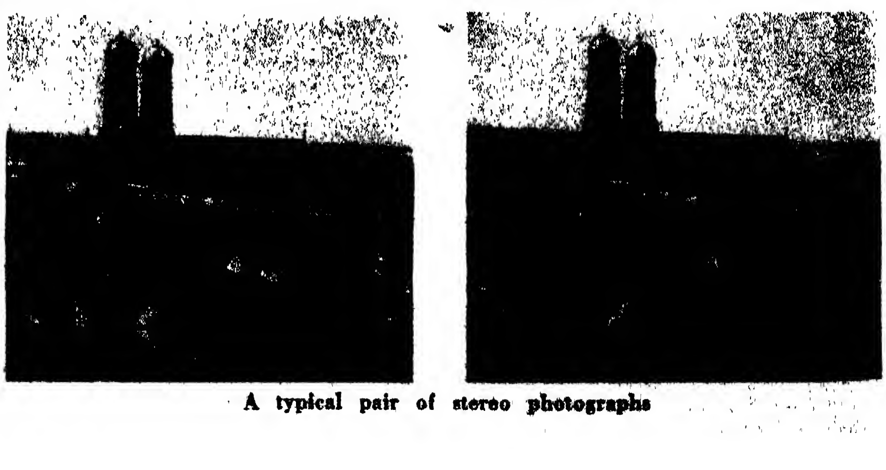
For projecting stereo photographs



How a projected stereo photograph looks when viewed without glasses

The resulting negatives must be printed differently from the method employed in normal, single-lens photography; that is, two prints are made, one for each of the recorded images. These are mounted side by side and viewed by means of a stereo viewer. However, since the images are inverted during the exposure, it is necessary to separate the double print by cutting across the center and interchanging or transposing the prints so that the picture taken with the left lens is viewed with the left eye and the picture taken with the right lens is viewed with the right eye. Where transparencies are made, correct printing is assured through the use of a transparency frame designed for the purpose.

Among the better type of stereo cameras are the Heidoscop and the Rolleidoscop;



A typical pair of stereo photographs

among the cheaper is the English Stereo Puck, a box camera type using 2¼ by 3¼ inch roll film and providing eight pairs of stereo pictures. Both the Heidoscop and the Rolleidoscop are available in models giving 6 by 13 cm or 4.5 by 10.7 cm stereo pictures, the one taking plates, the other roll film. Both are of the reflex type.

Single lens cameras have been successfully adapted to stereo work by shifting the position of the camera from 2½ to 2¾ inches, after the first exposure, to make the second. This adaptation of the single lens camera to stereo photography is limited, of course, to still subjects. Special stereo heads providing for the exact shifting of the camera for the two stereo positions are available as accessories for such cameras as the Plaubel Makina, the Rolleiflex, and the Leica. For the latter camera there is also available the

Stereo attachment for Leica

Stereoly Attachment, which contains two prisms positioned 2½ inches apart and slips over the regular 50-mm lens of the camera to reproduce two images on the single Leica negative.

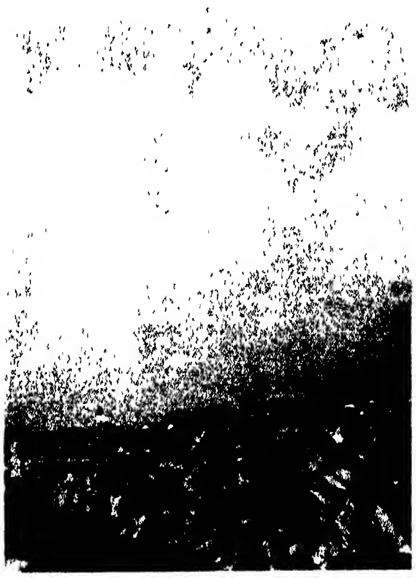
For viewing stereo pictures a variety of optical stereoscopes are available providing a magnified image. These range from the simplest device, such as the Eho Stereo Viewer, to the most elaborate viewing cabinets, which take stereoscopic prints or transparencies and automatically change from one pair of stereo pictures to the next. For projecting stereo pictures, the makers of the Leica camera have recently adapted their Stereoly Attachment for use on the Leitz VIII-S projector, with a pair of Polaroid filters mounted over the attachment. Since the screen shows two overlapping images, as shown in one of the illustrations, it is necessary for the spectator to wear a pair of glasses, the lenses of which are polarizing filters.

Those Vacation Shots

NOW comes the reckoning. You took pictures galore, of course, but how many were worth the taking? How many are worth the printing? Far from the bewitching influence of the subjects, you may now take stock and decide. Study the negatives carefully, project them under your enlarger, give them every chance. If the whole negative looks disappointing, maybe a part of it is worth while. If the negative won't stand up at all and is a complete flop, why waste precious time in printing it, even if "just for the record?" The time wasted in printing bad negatives may well be devoted to greater thoroughness in processing the really good negatives. And if the total of prints that may result from this weeding process is far less than the total of negatives you brought back with you from vacation, you may be sure your album will take on a finer dignity by the inclusion only of good pictures and the complete absence of the bad and indifferent ones.

At the Game

"AND a Goodly Crowd was There" is a type of picture that may be shot at almost any outdoor game. The audience is sometimes worth more attention than the game itself. Sections or small groups or individuals offer many striking opportunities. In the illustration, the view was arranged to show the crowd in the extreme foreground so that the interesting cloud formation would also be included.



"And a Goodly Crowd Was There"

Candid Shooting

THE candid subject still remains one of the most attractive fields for the user of the miniature camera. It was our good fortune recently to spot one such opportunity while strolling through a park one sunny afternoon. The "Crossword Puzzle Addict" was the result. Happily we had with us the twin lens reflex camera, which proved ideal under the circumstances. The subject was sitting at one end of the bench and we waited our chance until the park bench sitter at the other end decided to walk on, thus providing us with an ideal camera location. We turned the lens of the camera toward the

"Crossword Puzzle Addict"

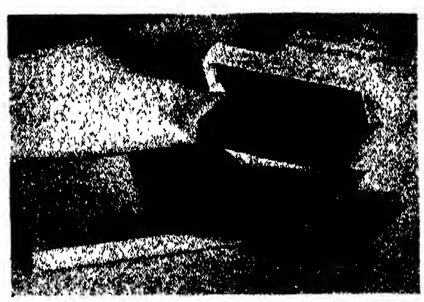
subject but observed the image at right angles. After focusing quickly and setting the camera in position, we poised the finger on the release and watched the subject directly, snapping the picture at $f/5.6$ and 1/50 of a second.

Viewers

A NUMBER of negative and transparency viewers have recently been placed on the market along with several types of transparency frames. While principally intended to furnish a pleasant method of viewing 35-mm color transparencies, these viewers offer a convenient means for examining 35-mm negatives under ideal conditions; that is, by transmitted light evenly distributed over the area of the negative, and with the aid of a magnifying lens fixed in the device. In this way negative strips are easily examined for sharpness, for contrast, and generally as to their suitability for enlargement either in whole or in part. A device of this sort would seem to be almost an essential in the equipment of every user of 35-mm negatives.

Home-Made Negative File

HERE'S an idea for those who have access to discarded Agfa cut-film containers. The enclosure, a drawer-type box



Film file

which contains the film, is used for filing the resulting negatives. The box itself is open at one end, a hinged end serving as cover, as shown in the illustration. The negatives are filed in individual glassine envelopes as a protection in handling. The top of the box is covered with a white sheet of paper on which is indicated a list of the enclosed

negatives, together with pertinent exposure and other data. The front end of the box is lettered with some general classification covering the entire contents. The whole arrangement affords a convenient system of filing large negatives as well as protection against dust.

Chromium-Plated Aluminum Cameras

EXCITING considerable comment is the process of chromium-plating aluminum discussed in an article in the July, 1938, issue of Scientific American. One of the first to take advantage of the new development is the Eastman Kodak Company, which is using this process on the new Super-Kodak Six-20 and the recently announced Bantam *f*/4.5 cameras.

Film Ratings

RECOMMENDED ratings for the new Eastman films recently announced in the "What's New" columns—Super XX, Plus X, and Panatomic X—are listed for Weston and General Electric meters as follows:

	Daylight		*Tungsten*	
For Weston Meters:				
Super XX	80	128	50	80
Plus X	40	64	24	40
Panatomic X	24	40	16	24
For General Electric Meters:				
Super XX		128		80
Plus X		64		40
Panatomic X		40		24

The second columns in the Weston figures provide for somewhat less dense negatives, while the ratings for the General Electric meters may be increased proportionately.

Writes Paul Favour, Manager of Eastman's Service Department:

"The values in the left-hand columns do *not* represent the least exposure which will give the best possible prints. They include a safety factor to take care of variations in the use of the exposure meters and in the handling of the photographic materials. On the average, the exposure called for by these numbers is more than twice that actually required for the best possible prints, but decreasing the exposure by that amount is not recommended unless the operator is thoroughly familiar with the characteristics of his exposure meter and of ordinary darkroom practice. The Weston numbers in the right-hand column represent a safe decrease in exposure under these conditions."

Versatile Darkroom Pail

FOR waste prints and other waste that piles up in the course of an evening's work in the darkroom, some amateurs use an ordinary galvanized tin or iron pail. However, experience has shown that a pail of this type soon corrodes and becomes objectionable in other ways, chiefly odoriferous. One might use a paper carton or a similar container, and throw it away, contents and all, but it would become somewhat of a chore after a time to make sure of providing such a container every time one is ready for the darkroom.

What's wrong with using a white enamel

pail? Not only is such a pail a good looking darkroom accessory, but it is easily washed and cleaned after a night's work, and it does not rust. Furthermore, a pail of the proper size may also be used for mixing up a good quantity of hypo fixing solution. Every darkroom addict knows what a nuisance it is to mix up a quantity of fixer with the regular darkroom graduates. The white enamel pail should offer a welcome solution to a vexing problem for many, as it has for this department.

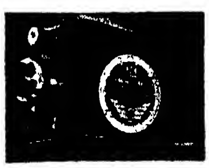
WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

SUPER SPORT DOLLY, with built-in visual type exposure meter ($65.00 to $82.50, depending on lens and shutter equipment): Has built-in range finder of split-field type. Available with Schneider Xenar and Zeiss Tessar $f/2.8$ lenses in regular Compur delayed-action shutters with speeds of 1 second to 1/250, and Compur Rapid with speeds up to 1/400. Uses 120 or B-2 film, taking 16 pictures 1⅝ by 2¼ or 12 pictures 2¼ by 2¼ inches.

FILMO 141, available in two models, 141-A providing speeds of 8, 16, 24 and 32 frames per second, and 141-B operating at speeds of 16, 32, 48 and 64 frames per second: Declared to incorporate improvements never before available to amateur movie makers. Among other things, the Filmo 141 features a new "projected area" view-finder, the four camera speeds, and a single-frame exposure device. The lens is the color-corrected 1-inch $f/2.7$ Cook and since the camera has the same lens mount as the Filmo 70, all lenses used on the latter cameras are interchangeable with the new model. The selection of focal lengths includes 15-mm to 6 inches with "projected area" view-finders for each. The view-finder is set in a soft rubber cup, thus preventing side glare.



Filmo 141 is small, and weighs only 39½ ounces. The camera is jet black and chromium, with inset panels of a new and durable hard-rubber composition finished in pin-seal grain. Built into one of the side panels is a complete exposure calculator. Available with the camera is a leather carrying case arranged to hold the camera, two film magazines, three lenses, and a complete set of view-finder units.

AMICO MOTORIAL TRIPOD ($48): Designed for use with both still and movie cameras, all movements being controlled by friction, the latter being adjusted to the weight of the camera being used. Panorama and tilting movements are made on cylindrical bearings, the tripod head carries a rectangular platform 1¾ by 2⅝ inches, and tilting may be had to any degree up to a complete right angle on either side. For pan-

framing, a circular scale of 360 degrees is provided, subdivided at every tenth degree. The tripod is made of duralumin in two sections and measures 36 inches when closed, 58 inches extended; weight 8½ pounds.

LAACK ENLARGING LENSES: TEXON ($20.50 to $67.00); DEFINON ($9.00 to $25.00). Texon ("tessar" four-element type, two elements cemented) focal lengths from 5.5-cm to 21-cm, with iris diaphragm, in barrel mounts, speeds $f/3.5$ and $f/4.5$. Texon 5.5-cm. $f/4.5$, and 10.5-cm, $f/4.5$, in spiral mount. Definon (three-element, uncemented) focal lengths 5.5-cm to 13.5-cm, with and without iris diaphragm, speeds $f/4.5$ and $f/6.3$, enlarging mount, except 13.5-cm, $f/4.5$, which has iris diaphragm and is in barrel mount.

UTILO ROLLFILM camera is available in two models, both equipped with the Meyer Trioplan $f/4.5$ lens of 4-inch focal length, designed to expose eight 2¼ by 3¼ inch negatives on 120 or B-2 film. The two Utilos differ only in the type of shutter provided, one with the Vario shutter ($15), the other with the Prontor II shutter ($18), the latter being provided with a delayed action release. Accessories available include a leather carrying case ($3); Orthoplan slip-on type filters in yellow 1, 2, 3, red, green, blue and ultra violet ($2 each); slip-on type supplementary lens ($4.50).

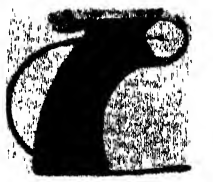
KEYSTONE SLIDE PROJECTOR ($34.50): For black and white or color films. Features a patented heat-absorbing unit designed to furnish protection against burning or buckling of the film. A built-in cooling chamber acts as an additional safeguard against excessive heating of the slides and makes possible longer showing of individual transparencies. Other features include: 200-watt illumination; $f/4.5$ five-inch Wollensak projection lens; three-piece condenser unit; automatic centering of slide carrier on each picture; 2 by 2 inch standard slide holder; die-cast lamp-house and cast base with leveling screws; size, 10½ by 7¾ by 9½ inches; weight, eight pounds.

CURTIS DUFAYCOLOR PRINTER ($69.50): Designed by Dr. Thomas Curtis for color separation of Dufaycolor transparencies 4 by 5 inches or smaller. Special voltmeter controls light source. Voltage control dial permits cutting voltages of 108 to 125 down to 105 to obtain correct printing voltage for color balance. Peep hole aperture shows which filter is in position. Filter slide locks into position built-in red, green, and blue filters, as well as white filter for black and white printing. Light source supplied by special lamp having constant color-temperature life of 1500 hours. Graduated diffusion plates spread light rays for uniform lighting. Built of Aircraft Duralumin and wood fiber, formed under hydraulic pressure. Measurements: 12½" high, 11" long, 10½" wide. Weight: 7½ pounds. Supplied with printer: Insulated plug-in cord 12 feet in length; special cellulose acetate matte for use beneath

transparency to eliminate Newton rings in negative; transparency covering of cellulose acetate, 1/2000ths" thick, to prevent false light-scatter by dust between transparency and negative; complete instructions. Advantages listed by manufacturer: three correctly balanced Dufaycolor separation negatives in half an hour; correctly balanced negatives by giving equal exposure to all three negatives; good definition making possible 8 by 10-inch enlargements from pictures as small as 1⅝ by 2½ inches; your own paper prints with any standard method of color printing.

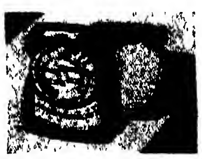
SEVEN-SECTION BROOKS POCKET TRIPOD ($7.00): Each leg telescopes independently (each has its own release catch). Master release catch on top section. Weight 10 ounces. Closed measures 10¼ inches long; extended, 46 inches. Made of aluminum and steel alloy. Top section finished in black enamel.

P. U. TRIGGER TRIPOD ($1.50, with cable release): Polished wooden "pistol grip" for steadying small camera. A 10-inch cable release fits camera shutter and terminates in "trigger guard." Permits operating camera with one hand; recommended for slow shutter speeds. Takes all small, hand-held cameras fitted with tripod socket and cable-release socket.



KODAK DARKROOM OUTFIT NO. 3 ($4.25): Includes one darkroom lamp; three 4 by 6 trays; one 8-ounce graduate; one 3¼ by 5½ printing frame with glass; one 8-inch glass stirring rod; a one-pound package of acid fixing powder; one tray thermometer; two film clips; six blotters, 9½ by 12 inches; one set of three rubber finger tips; one package of 5 by 7 mask charts; one copy of "How to Make Good Pictures;" two dozen sheets of Velox paper, 3¼ by 5½ inches; one instruction booklet; and five tubes of Universal developer.

DE JUR AMSCO PHOTOELECTRIC EXPOSURE METER ($10.50): Calibrated up to speeds of 200 Weston, this is the latest of the small electric meters to appear on the market. It is shown in the illustration compared in size with a golf ball. Featuring a single ring for adjusting the four variables—light intensity, film speed, shutter speed, and diaphragm opening—the new meter is employed at waist level and is said to incorporate the most recent developments in this field. The moving hand is mounted on jeweled bearings "so that the slightest light impulse will give an accurate reading."



ROBOT OMEGA ENLARGER ($63 to $78, depending on lens furnished): Designed specifically for enlarging from Robot one-inch square negatives. Similar in every respect to the Omega Miniature Enlarger with the exception that it carries a built-in mask for the Robot square format.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. **I would appreciate some accurate information as to the best method for obtaining platinum prints from regular camera negatives. Also information regarding the process used years ago for "carbon" prints.—R. G. M.**

A. Platinum paper, largely because of its high cost and other difficulties, is not now so generally employed as it used to be and is, in fact, obtainable only from a single firm under the name of Platinotype. The firm is an English one and is the same one that was established in 1880 by the inventor of the process, W. Willis. The following developing formula is recommended:

Potassium oxalate	3 ounces
Potassium biphosphate	24 grains
Oxalic acid	6 grains
Water to	20 ounces

Two or three successive treatments with dilute hydrochloric acid follow development. This acid solution is made up of 1 part of concentrated acid and 60 parts water. A fresh bath is used for the last treatment, the latter being followed by thorough washing in several changes of water.

A rather full discussion of platinum printing will be found in Clerc's "Photography, Theory and Practice" and Neblette's "Photography, Principles and Practice." The same sources also give detailed information on the carbon process. The principal attraction of the latter process probably lies in the fact that the carbon tissue employed is available in many colors. The tissue (paper coated with a solution of gelatin and pigment) is sensitized in bichromate, exposed under the negative and transferred before development to another support. The pigmented gelatin adheres to the new support as the tissue backing is stripped off. Washing away the soluble gelatin in water constitutes the "development" procedure.

Q. **Will you please discuss the advantages and disadvantages (if any) of the film-pack type of camera as compared to the roll-film type camera intended for general use?—C. W.**

A. Generally, it is a matter of personal choice dictated largely by the type of work one intends to do. One outstanding advantage of the film-pack type is that of ground glass focusing, which is often desirable. Film, both film pack and cut film, can be developed individually and a greater variety of emulsions is available than is at present obtainable in roll film. Also, since the negatives are usually larger than those made with roll-film cameras, many will find in this the advantage that contact prints of good size may be made from the negatives. The roll-film camera, on the other hand, particularly of the miniature type, is usually more easily manipulated than the film-pack camera, and a greater film capacity is possible, as in such cameras as the 35-mm and vest-pocket type. Development is simplified because negatives may be developed in strips rather than handled singly. However, there are some cameras that take both film pack (as well as cut film) and roll film by interchanging backs so that no dilemma on this score arises at all.

Q. **The other day I was going through the attic and I came across some old photographic plates. In storage they had accumulated dust and I wonder if there is any way in which they can be cleaned so that more prints can be made from them.—L. S.**

A. A thorough rewashing of the plates should rid them of dust completely. Several changes of water rather than continuous washing in a single tray will probably be the best plan. After washing, swab both sides gently before setting up to dry.

Q. **I wonder if you have any list of accredited schools in photography that you could send me. If you do not have any such list perhaps you can tell me of schools of photography around Rochester, New York.—J. B.**

A. We do not happen to know of any such list of schools in your vicinity but you should have no trouble in obtaining such a list from the Service Department of the Eastman Kodak Company there and obtaining similar assistance from the Chamber of Commerce of that city. Both of these organizations will recommend only the good schools.

Q. **I use a 3¼ by 5½ plate camera. My finder, of the conventional brilliant (waist level) type, is out of alignment and unsatisfactory in other ways as well. My solution is an eye level, direct-view finder of the type on the Eastman Bullet camera. Can you give me the sizes**

of openings in the above type of finder and the distance between the two?—C. H. M.

A. Probably all your brilliant finder needs is a little adjustment to bring it back into alignment again. It sometimes happens with your type of finder that in closing the camera the finder bracket is accidentally bent, in which case the agreement between the field of the finder and that of the lens will naturally be broken. As to the measurements for the direct-view finder you mention, these are simply scaled down from the negative size. The front opening of the finder may be scaled ¼ to the inch and the back or eye-piece, ⅛ to the inch, with the distance between the two about 1 inch. By these scales, the front opening will measure 1⅝ inch by 13/16, and the smaller opening back of it, 11/16 by 13/32 inch.

Q. Can you tell me the duration of the time lag on single lens reflex cameras between the time of the release and the actual exposure?—D. M.

A. Between the moment that the mirror flies up out of the way and the actual start of the uncovering of the film by the focal-plane shutter curtain, the lapse has been variously estimated as between 1/10th and 1/40th of a second. However, this is merely a guess and it is probably safe to place the lapse at about 1/30th of a second.

Q. Can you recommend an effective hand stain remover?—S. E. L.

A. The following Eastman formula S-5 has been found to give good results:

Solution No. 1	
Potassium Permanganate	¼ ounce
Water	32 ounces
Solution No. 2	
Sodium Bisulphite	16 ounces
Water	32 ounces

Rub the hands with a small quantity of the No. 1 solution, and rinse with the No. 2 solution.

Q. For some reason my camera leaves too great a space between the frames so that I am able to get only ten full negatives and a part of the eleventh; the space between them is about ⅞ of an inch and is uniform for the whole roll. The importers have refused to correct the error. I believe I can make the adjustments myself. What is your suggestion?—W. A. S.

A. The trouble lies, obviously, in the winding mechanism of your camera and is a fault that should be corrected by the makers or their representatives. Since you say they have refused to do this, your other alternative is to take your camera to an expert camera repair man. This fault has rather complicated reasons and it would not be advisable for a layman to attempt to correct it.

Q. I am the owner of two cameras with Compur shutters and should like to know how they operate. Recently I have heard the theory expressed that the Compur shutters are the least accurate of any type of shutter used in cameras. Is this true?—J. B. T.

A. On the contrary, Compur shutters are regarded by many as the leaders in their field and remain fully accurate with proper usage and care; that is, periodical testing of the several speeds. But this is true of all shutters. One sure indication of their high efficiency is the fact that the Compur and Compur Rapid shutters are being employed on some of the most expensive cameras in use today. The Compur shutter operates on a system of gear wheels for the faster speeds, with an escapement for the automatic exposures that range from one full second to 1/10th of a second.

Q. Were I telling a person that the lens on my camera has a speed of *f*/3.5, please state in words (not numerals) just how this should be repeated. I was corrected recently on the way I say this and wish to know *who* is correct.—Miss M. A. B.

A. This is usually stated: "F, three, five."

Q. Can you please tell me what caused the round spots on the enclosed negative? It was developed in Agfa formula No. 17, and I thought I followed the directions to the letter. Also, please tell me what the Weston and American Scheiner ratings are for the new film, Agfa Superpan Supreme—A. F.

A. There's nothing wrong with your negatives, which, by the way, should make fine enlargements, but the next time you develop a roll of film make sure your tank is clean. The transparent spots on your negatives were caused by particles of dirt or dust in your tank. Before loading the reel, you can avoid similar results first by cleaning the tank thoroughly; second, by soaking the film in water for a brief period before pouring in the developer.

The Weston ratings for Agfa Superpan Supreme are 64 in daylight, 40 in artificial light; the American Scheiner ratings, 26 and 24, respectively.

Q. Will you please advise me how to dry prints in a so-called "lintless" blotter book so that they will not stick to the blotter? I used a double weight enlarging paper and washed it thoroughly for about 10 hours in running water before placing the prints face down against the blotter with their backs to the wax paper fly leaves, and still they stuck. Why?—K. L. R.

A. In the first place, 10 hours of washing is much too long, for prolonged washing tends to degrade the brilliance of the print. One to two hours in running water is ample for getting rid of hypo in prints; beyond that the print is simply soaking. Your difficulty with the blotter book is apparently due to the fact that you are following only half the routine involved in drying prints by this method. After the print or enlargement is removed from the wash water, the water should be allowed to drain off for a few moments and the print then placed face down on one of the blotter leaves in order to remove excess moisture. Then turn the print around to *face the wax paper*. An alternative, and perhaps more effective method, would be to have some extra photographic blotters handy for removing the excess moisture and then place the prints in the blotter book with face to wax paper and back to blotter leaf. By this method, the print would first be placed between two blotters and some pressure applied with a roller. This would leave less work for the blotter book and so expedite drying.

Books

SELECTED BY THE EDITORS

MORE LIVES THAN ONE

By Claude Bragdon

HERE is a rich and unusual autobiography whose appeal is as many-sided as Mr. Bragdon's own career. Once a leading Rochester architect and a friend and disciple of Louis Sullivan, Mr. Bragdon designed several notable buildings. At the height of his career as an architect, he turned his talents to the theater, making a second reputation as stage designer for Walter Hampden. Those of our readers who followed our spiritualistic investigations some years ago would be interested in the occult studies of Mr. Bragdon, in which he has achieved his greatest distinction. The mysticism of the East is known to him as to few Occidentals. He collaborated on the translation of Ouspensky's *Tertium Organum* and was largely responsible for his introduction to American readers. Claude Bragdon has cast a vivid backward glance, and has caught much of the fullness of his four-dimensional life—as writer, architect, stage designer and mystic—in his life story. Few men have lived so fully or written of their lives so vividly.—$3.95 postpaid.—*A. M. T.*

HOW TO MAKE GOOD MOVIES

THE pleasure to be gained from the movie-making hobby is the sole thesis of the book and to this end it "picks up the story where the instruction manuals leave off." Splendidly illustrated, partly in color, the book discusses, in word and picture, such subjects as close-ups, color film, continuity, duplicates, editing, fades, film, indoor movies, lenses, panoraming, plays, projection, reverse action, slow motion, trick shots, and many other subjects, in all comprising a complete handbook for the amateur movie maker. A pocket inside the back cover contains two Kodachrome Exposure Guides, one for Type "A" film (artificial light), the other for use in daylight. (230 pages, more than 600 illustrations.)—$2.15 postpaid.—*J. D.*

DEMONSTRATION EXPERIMENTS IN PHYSICS

Edited by Richard Manliffe Sutton, Assoc. Prof. Physics, Haverford College

TO this book over 200 physics teachers contributed a total of 1200 direct, practical, but compact recipes for physics teachers and others of equal background, outlining experiments having good "showmanship" content. (545 pages, 6 by 9 inches, 408 illustrations.)—$4.75 postpaid.—*A. G. I.*

THE AMATEUR GUNCRAFTSMAN

By James Virgil Howe

A FRIEND surprised us recently with the statement that there is a rapidly growing interest in the hobby of remodeling old guns. This volume is intended for such gun lovers who like to tinker with their firearms, making new stocks, new sights, and other parts. The author, who is a veteran gunsmith, has covered many points that are of interest to such tinkerers in this popular but thoroughly practical work. His discussion also includes many usable facts regarding oils and polishes, and information on the best way to keep one's gun in first-class condition. (301 pages, 6½ by 9¼.)—$4.20 postpaid.—*F. D. M.*

THE MIND OF THE JUROR

By Albert S. Osborn

WHILE this book is repetitious and long-winded, and is padded with many statements of commonplaces it also contains the impressions of a man who for many years has had an almost unequalled opportunity to observe the workings—or perhaps the creakings—of courtroom procedures in nearly every state of the union; readers will recall him as the handwriting expert at the famous Hauptmann trial. In minute detail he points out the inefficient, time-consuming performances of many of our courts of law. The author shows also that the same situation once obtained in England but, the lawyers there not moving to remedy it, the people did it themselves. It can also happen here. (239 pages, 6¼ by 9¼ inches.)—$4.70 postpaid.—*A. G. I.*

STARCRAFT

By William H. Barton, Jr., Hayden Planetarium, and Joseph Maron Joseph, Science Dept., Smedley Junior H.S.

FINDING and learning the stars of the constellations, making your own star charts, never lost with the stars (finding one's position), getting way out into space, making sundials, making a reflecting telescope—these are some of the subjects, largely practical, dealt with in this excellent book. It is full of practical things to do in learning astronomy. A keen lad of 12 to 16 would find it a treasure-house of astronomical lore—so would an adult. Intended primarily for youths, it is not "juvenile." That is, instead of being written in some special approach which adult authors too often imagine a youth requires, but which a youth at once spots as "phony," it consists of those parts of grown-up astronomy which can be explained to a youth, explained in grown-up language and approach. (228 pages, 6 by 9 inches, many illustrations and charts.)—$2.65 postpaid.—*A. G. I.*

We can supply our readers with any of the books reviewed in this department. Prices quoted include domestic postage. Foreign prices are necessarily higher due to increased shipping charges.

SCIENTIFIC AMERICAN
24 West 40th Street New York, N. Y.

SHIPS OF THE NORTH ATLANTIC

By A. G. Horton White

YACHTS, YACHTING & SAILING

By PayMr. Lieut.-Commander E. C. Talbot-Booth, R.N.R.

FIGHTING PLANES OF THE WORLD

By PayMr. Lieut.-Commander E. C. Talbot-Booth, R.N.R.

THESE three separate volumes in a steadily growing list of similar books, while having a British slant, are complete in every respect. Each covers its subject matter in long discussions, hundreds of drawings and photographs, numerous plans and tables, maps and color charts. Each provides an invaluable reference and makes fascinating reading for those interested in these subjects. (Each book is 4¼ by 5½ inches; total pages are 523, 612, and 608 respectively.)—Sold separately, $3.20 each postpaid.—*F. D. M.*

Books Recently Received

BUSINESS CORRESPONDENCE AND OFFICE MANAGEMENT—*By Edward A. Duddy, L. E. Frailey, and Raymond V. Cradit.*—Methods, machines and systems for the business office to make it more efficient.—$1.95 postpaid. . . . MARVELS OF THE INSECT WORLD—*By Jean-Henri Fabre.*—A new edition, annotated and translated by Percy F. Bicknell, of a famous volume by a famous insect man.—$2.65 postpaid. . . . THE STORY OF WATER—*By Augustus Pigman* and edited by Alice V. Keliher.—A light study of the problem of water supply for civilized communities throughout the ages.—$1.60 postpaid. . . . THE STRUCTURE OF STEEL SIMPLY EXPLAINED—*By Eric N. Simons and Dr. Edwin Gregory.*—For everybody who has to do with steel: steel user, student, layman, or worker.—$2.15 postpaid. . . . PAINTING AND DECORATING—*By J. Ralph Dalzell and Alvah Horton Sabin.*—Mixing formulas, directions for all kinds of painting, and how to obtain unique surface effects. For painters, decorators, and contractors.—$1.65 postpaid. . . . CHANGING THE SKYLINE—*By Paul Starrett.*—The autobiography of an architect which is as fascinating as the skyscrapers in which he was largely interested. Many of the giant intellects of recent years helped to make the story which he tells.—$3.20 postpaid. . . . FLYING VISTAS—*By Isaac H. Jones, M. D.*—An informative book discussing the human being as seen through the eyes of a flight surgeon who believes that aviation can make us understand our physical selves, for the man who is "fit to fly" is an exceptionally keen human being.—$2.15 postpaid.

FOR OTHER BOOKS YOU WANT, SEE PAGE 262

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

As is pointed out in "ATM" (p. 160) the telescope maker may use a machine for his glass grinding, or he may use his hands. Either method is satisfactory. Many, however, actually enjoy the fun of cooking up a machine, also of watching it work while they lean back and smoke. From the depths of the drawer in which things some-day to be published are kept, we draw forth a group of accumulated letters, with photographs, describing grinding machines made by our readers.

Figure 1 shows a machine, made by Loyd A. Magruder, 800 Ashman St., Sault Ste. Marie, Mich. It has direct gear drives and is of all-iron construction, made, as Magruder points out, largely of junk and with very few tools. The stand consists of two old auto flywheels bolted to legs sawed from old auto frames. The oscillating cross member is driven from two crank arms, one of which shows in profile. The rest is a matter of gearing. Possibly, as someone has pointed out, the bevel gears and pinions could be backed up more closely with bearings, to get away from flexure and chatter, yet the actual forces involved in working a small mirror are rather low and the proof of the pudding is that this machine has been a success.

Magruder's design embodies some brass castings, in making which he found that the brass could be melted at the hot point of a home furnace stoker, using a crucible improvised from waste electrodes obtained for a few cents from a carbide company. He plans next to tackle a ruling engine. [Commenting on this, R. E. Clark, author of the chapter on small lenses, "ATMA," says: "Several years ago I tried to make one. Making the master screw is a heart breaker, and trying to make the thing perform is still worse." Practical instructions for making the screw are contained in Vol. IV of Glazebrooks' big "Dictionary of Applied Physics."]

Concerning the large machine shown in Figure 2, we have no data, beyond the fact that one of its builders was Geo. I. Moe, 4118 N. 16 St., Tacoma, Wash., and that it was built for use in grinding a 24" mirror of Pyrex which for several years has been theoretically under active construction by the Tacoma Amateur Astronomers.

The machine shown in Figure 3 is the one used at the Warner and Swasey Co. shops, in Cleveland, Ohio, for grinding and polishing the 80" mirror for the McDonald Observatory in Texas.

A long time ago we asked whether anyone had made a first mirror on a machine, with no previous hand experience to learn the "feel" of the work, and John MacDonald, 828 N. Hibbard Ave., Jackson, Mich., sent us the photograph shown in Figure 4, with the comment that "the answer is emphatically, 'yes.' I have a 10" reflecting telescope in the course of construction which is primarily designed for photographic work. The focal ratio of the Pyrex mirror is 6.5. It was 'machined' on a similar disk of Pyrex through the various grades of grinding. When grinding was complete, the tool was covered with the conventional pitch lap, and on this the polishing and figuring were completed. The 'shift' of the knife-edge in the Foucault test, determining the difference of focal length between the central and outer zones of the paraboloid, can be lengthened or shortened at will, without any alterations in the shape of the facets.

"The machine was designed and built by myself, and is of the transverse bar type. It is adjustable to any stroke desired. The difference in the speed of rotation between mirror and tool can also be regulated. The mirror and tool both rotate in the same direction, but at different speeds. The rotating action of mirror and tool is produced by over-running clutches, which prevent any ratchet action and consequently do not permit any synchronism of the intermittent turning action of mirror or tool. The transverse bar slides on hardened steel rollers, and can be raised or lowered to accommodate any thickness of glass, and the grinding pressure is adjustable from nothing to 60 pounds."

The little machine in Figure 5 was also made by MacDonald and is for grinding small lenses. It may be run vertically for grinding and polishing, and horizontally for

Figure 1: **Magruder's grinding machine**

Figure 2: **The Tacoma amateurs' machine**

Figure 3: **Large machine, Warner and Swasey**

Figure 4: **MacDonald's mirror machine**

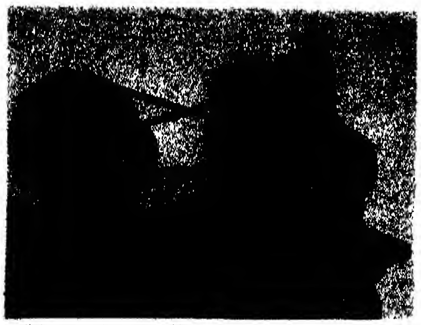


Figure 5: MacDonald's lens machine

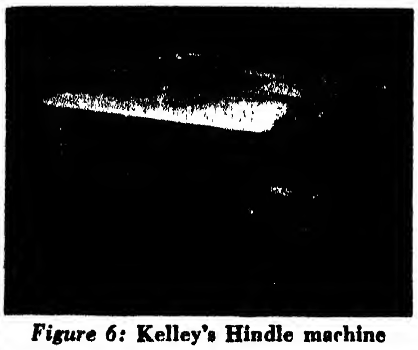


Figure 6: Kelley's Hindle machine

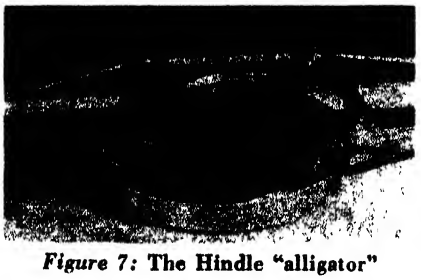


Figure 7: The Hindle "alligator"

centering, edging, and testing such work.

Hindle's alligator machine (so-called because the part on top which moves the mirror back and forth resembles an alligator in shape, when seen in plan) is becoming justly popular. We learn of two on Long Island, and Figures 6 and 7 show another, probably as finished in design and appearance as a machine could be made. The maker is the same Emir Kelley we mentioned in the October number—the Kelley who built a grandfather clock which automatically raises a flag and blows a whistle on his wedding anniversary, as a warning not to forget. Of this machine, Kelley (of Kelley and Stewart, South Brownsville, Pa.) writes in reply to our request: "It has a three-point base for leveling. The turn-table may be thrown out of gear, permitting easy rotation by hand for centering the tool. The tool is clamped in place by three eccentric, knurled disks, with a scrap of aluminum between disks and tool, making a very rigid chuck. The turntable and cranks are mounted on ball bearings, reducing friction and lost motion to a minimum. Figure 7 shows the central part of the alligator, with mirror floating between adjustable rubber-tipped push arms. The frame is adjustable for height, to provide a straight-line drive to the mirror."

Another Hindle alligator machine is shown in Figure 8, a photograph sent us by Franklin B. Wright ("ATM," chapter on accuracy in parabolizing, and "ATMA" chapter on theory and design of Schmidts), who says the machine was built by Carl E. Wells, 419 Oak St., Roseville, Calif., also that "the most beautifully figured mirror I have ever gotten a knife-edge in front of

THE BEGINNER'S CORNER

THIS is the beginning of "The Beginner's Corner," set aside from the more advanced discussions of the amateur telescope making hobby to be found in the surrounding department, and it will endeavor to live its life on the level of the average beginner, avoiding the more rarefied atmosphere in which the advanced amateur telescope maker customarily dwells. Its purpose is quite frankly to interest the new readers of Scientific American in the telescope making hobby, which has been dealt with by this magazine in nearly every number since 1926.

Actually to tell here how to make a telescope would not be practicable, since that would require too many words. This is told in detail in the book "Amateur Telescope Making." However, four very simple telescopes of the kind sometimes chosen by the beginner from those described in that book are shown above. These telescopes have no tube, but a tube is not a necessity on a telescope. The long column of wood, pipe or other material, serves to support the large concave glass mirror at its bottom, and at its top a crosswise member carries a diagonal mirror and an eyepiece.

Such a telescope, simple as it is, will magnify 50 diameters. Take, for example, the second one shown above. Its builder, Ralph B. Rice, 17 Maple St., Saugus, Mass., says: "With this telescope the Moon is a wonderful study, Venus shows a beautiful, clean-cut crescent, Jupiter lights up the eyepiece like a sun, and Mars shows large and red."

The cost of construction varies with the amount of materials which can be picked up locally. A few have made such telescopes for $8 or even less but it is better to count on about twice that sum (which is, however, a conservative, outside estimate).

In the surrounding department there are shown, this month, photographs of a number of machines for grinding mirrors. This may mislead the reader into the belief that such aids are necessary. Far from this, machines are much the exception, and most amateurs, tyro or advanced, grind their mirrors by hand. At least 10,000 Scientific American readers have made their own telescopes.

TELESCOPTICS

(Continued from page 275)

was made by him." Wells, not Wright, is included in the photograph.

In the May, 1937, number two amateurs designated as "Castor and Pollux, the Gemini Twins"—namely, Edward P. Woolcock and W. E. Lester, 319 Hermosa Ave., Long Beach, Calif.—told how they were working on a 20" disk by means of a simple vertical spindle. Later they built and substituted for this the machine shown in Figure 9. Woolcock describes this as follows:

"The grinding machine is of the Hindle type and uses the familiar alligator principle, as explained in 'ATM.' We were able to make the machine for a total cost of $20, exclusive of the motor. Flat belts and pulleys are used to drive the three spindles

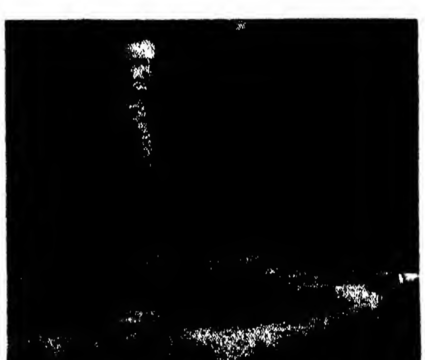


Figure 8: **Wells and Hindle rig**

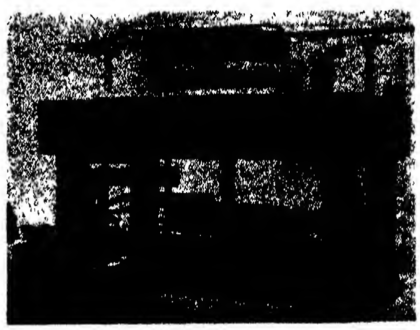


Figure 9: **The Twins' Hindle rig**

at varying speeds. The diagram shows our belt and pulley arrangement, and Hindle on pp. 234-240, 'ATM,' gives the explanation.

"As Hindle states, the machine gives an ovoid stroke, which can be varied at will by changing the bolt on the eccentric drive shaft. The stroke overhang can be varied by placing the drive bolt in different holes in the alligator. The side swing can be varied by changing the bolt on the other eccentric shaft. The rubber cleats on the alligator are not used to hold the mirror, but they are spaced about 1/4" from the mirror's edge and act only as pushers. Their operation is unique for, because of the spacing between cleats and mirror, the mirror actually turns in a direction opposite to that of the tool which is rotating beneath it. This amount of mirror turning can be varied by changing the separation between the rubber pads and the mirror. At each swing of the stroke the mirror is pushed at a

place about ½" from where it was last touched by the rubber cleats.

"The ovoid stroke helps to keep abrasive and moisture on the tool—we were able to grind for ten minutes at a time without replacing grit or using extra water. In the finer grades we ground for 20 or 30 minutes at a time, only occasionally squirting water from a toy squirt gun along the edge of the tool. The ovoid stroke quickly carries any moisture to the center of the tool, where it is dispersed equally over the grinding surfaces.

"We were able, by means of this machine, to grind from No. 80 through emery in two days. By hand this would have taken two weeks. We ground for 1½ hours on each of six grades of Carbo., and fine emery. This

Figure 10: Hiner's Herschel-Lee rig

time is actual abrading time and does not include time out to change grit, etc.

"Ronchi tests indicate that we have a perfect sphere with the strokes we have been using.

"Our favorite polishing speeds have been near 4 r.p.m. for the tool, 40 r.p.m. stroke, and 10 r.p.m. side play. All the speeds have been varied from time to time, using strokes from 4" to 8", with a 2" to 4" overhang and a mirror rotating speed of about ¾ r.p.m.

"As can be seen in the picture, we used a small drill press to supply our power (1/3 h.p. motor) and to give us our first speed reduction and variable speed arrangement (by shifting the V-belt on the two multi-step pulleys).

"We had time to read 'ATM' and 'ATMA' during work and we don't feel a bit tired after 5 or 6 hours of polishing! The various motions of the mirror during polishing are equivalent to pushing the mirror over the lap at the rate of 1 mile per hour."

Figure 10 shows a small machine of the Lee type ("ATM," p. 160) made by W. B. Hiner, 123 Cleaves Ave., San Jose, Calif., polishing a 6" mirror. It makes 40 strokes per minute, of length from 2" to 10" (adjustable) and with tool and mirror turning in opposite directions, mirror on top. It will take up to a 12" mirror and has been used by Hiner on three mirrors. The Lee type of machine is generally similar to one described in an ancient book, "The Telescope," published in 1861 by the younger Herschel (Sir John), and designed and used by his father, Sir William Herschel.

We greatly regret that another group of machine descriptions, sent us earlier than the above, was lost in the mails when temporarily lent to an amateur who was building a machine, and was never recovered.

LAST August, F. M. Garland of Pittsburgh described here his methods of marking mirrors by different kinds of etching. We now discover that Lyman Nichols, 118 Liberty St., New York, N. Y., an amateur telescope maker, has developed special inks, black and white, for writing in white or black on glass and other smooth-surfaced kinds of materials. It does not etch but it is otherwise very solidly affixed.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

DRAUCKER DAYLIGHT CALCULATOR is a pocket-size "slide-rule" device for either the movie or still photographer. It is very simple in operation and when properly set gives the correct diaphragm opening and shutter speed to be used under any photographic conditions. It is accompanied by a 12-page booklet of hints useful to the photographer. *Munder Electrical Company, Springfield, Massachusetts.—60 cents.*

COSMETIC MANUAL is a 94-page vest-pocket size book which presents formulas for the manufacture of all types of cosmetic preparations. Data are also given on manufacturing processes, precautions, hints, and general facts regarding the composition of creams and lotions. The Manual is available to manufacturers, chemists, and technicians. *Glyco Products Company, Inc., 148 Lafayette Street, New York City.—25 cents.*

LOW COST HEATING SYSTEMS is a 12-page illustrated folder showing up-to-the-minute designs of heating installations for small, low cost homes. It includes simplified plans of eight homes, together with material lists for the various heating systems adapted to each individual type. *American Radiator Company, 40 West 40th Street, New York City.—Gratis.*

TUBE-TYPE RESISTOR REPLACEMENT CHART is a handy wall chart which gives a complete listing of interchangeable and replacement tube-type resistors in various radio receivers. The chart consists of seven pages eyeletted together. It is of particular interest to the merchandiser or the radio service man. *Clarostat Manufacturing Company, Inc., 285 North Sixth Street, Brooklyn, New York.—25 cents.*

WIDER HORIZONS tells the story of corrected eye-glass lenses that are so designed that the glasses and defective eyes as a combination will function as satisfactorily as "perfect" eyes alone. In 16 pages are discussed the reasons why glasses are needed, how they are corrected, and how they can be of benefit to you. *Bausch & Lomb Optical Company, Rochester, New York.—Gratis.*

NICKEL—A VERSATILE AUTOMOTIVE METAL, by H. E. Blank, Jr., is a 12-page circular which presents in detail different applications of nickel alloys, in automobiles and aircraft. Illustrated with photographs and accompanied by a number of important tabulations. *The International Nickel Company, Inc., 67 Wall Street, New York City.—Gratis.*

FOURTH ANNUAL REPORT OF THE FEDERAL HOUSING ADMINISTRATION gives the facts of the F. H. A. up to December 31, 1937, including a general review of the purposes and functions of the organization, its methods of operation, and other facts of interest to taxpayers and home owners. House Document No. 696. *Government Printing Office, Washington, D. C.—Gratis.*

INDO-AMERICAN TRADE RELATIONS, by the Hon. Nalini Ranjan Sarkar, is a survey of export and import trade between India and the United States. It is essentially a plea for better mutual understanding of the problems involved and for a new orientation of trade policy. *India Chamber of Commerce of America, Inc., 665 Fifth Avenue, New York City.—50 cents.*

MINERALS YEARBOOK, 1938, is the only official record of mineral production in the United States. In 1339 pages, including a comprehensive index, is presented a complete economic and statistical summary of the mineral industry. Technological progress, world conditions, and foreign trade are accurately reviewed. Included is a comprehensive survey of the bituminous coal industry. *Superintendent of Documents, Washington, D. C.—$2.00.*

THE STORY OF FAITH THAT LED TO FORTUNE tells the human-interest story of the life of Robert Gilmour LeTourneau, a man who has been largely responsible for the development of modern road building and repair equipment. The story shows what can be accomplished through tenacity of purpose founded upon common sense. *The Lincoln Electric Company, Cleveland, Ohio.—Gratis.*

LOCAL BIRD REFUGES, by W. L. McAtee, deals with means for attracting birds to the home and community. It tells of the economic and esthetic value of birds, how they may best be fed, and what measures should be taken to protect them from their natural enemies. The material is adaptable to all sections of the United States. Farmers' Bulletin No. 1644. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

NOTES ON FAULT LOCATION IN CABLES is a 52-page pocket-size booklet which will be useful to anyone concerned with trouble shooting in communication systems or electric-power transmission. It explains the methods involved, gives diagrams, and illustrates and describes the necessary equipment. Notebook E-53-441. *Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

FEEDING WILDLIFE IN WINTER is a 22-page pamphlet that gives practical suggestions for assisting upland game, water fowl, small mammals, and big game in getting through those months of the year when their natural food supply is at its lowest ebb. Photographs and drawings illustrate the compact and comprehensive text. Farmers' Bulletin No. 1783. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

TEACHING CONSERVATION OF WILDLIFE THROUGH 4H CLUBS, by Ruth Lohmann, is published in an endeavor to create among the youth of this nation a knowledge of wildlife and a demand for its conservation for the future. Miscellaneous Publication No. 291, U. S. Department of Agriculture. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Exhausted Combination

INVENTORS frequently ask whether a patent can be obtained on an old combination of elements where one of the elements has been improved. The question is not free from difficulty. However, the generally accepted rule is that where the improvement of one of the elements of the combination results in a new functional relationship between the elements or in a new mode of co-operation, a patent on the combination can be obtained. Where, however, the improvement of the element does not change the coaction of the several elements or parts of the combination and the elements continue to act and co-operate in the usual manner, no patent can be obtained on the combination.

This principle is exemplified in a recent suit for patent infringement involving a patent on a casement window structure. The claims of the patent were drawn to the combination of a frame, a window sash, and an operator for the window sash whereby the sash can be opened and closed. The combination of the three elements was, per se, old. However, one of the elements, namely the operator for the sash, was improved. The Court found that the improvement of the operator did not change the co-operative relationship of the several parts and that the operator still worked in the same manner to open the sash. As a result the Court concluded that the patent was invalid.

The Court succinctly stated its reasons for invalidating the patent as follows:

"All of Doering's claims cover a combination which includes the elements of window-frame, sash and operator, and many of them contain other elements. The invention, if any, consisted merely in the improvement of one of these elements—the operator. If there were some new functional relationship between the operator and the other parts of the structure, it would be permissible to claim the entire combination. There is, however, no new mode of co-operation involved."

Nolan Act

AS previously pointed out on this page, the World War not only profoundly affects the present-day politics of the world but also affects the current administration of the patent law. Ordinarily, where a patent is obtained abroad by an inventor he must file his application for his United States patent on the same invention within one year of his filing date abroad. During the World War, communication between the various countries of the world was seriously affected and many inventors were unable to comply with this requirement. Shortly after the World War the Nolan Act was passed which permitted inventors who had filed applications abroad during the World War to file applications for the same invention in the United States prior to September 3, 1921.

A recent suit for patent infringement involved a patent which was applied for under the Nolan Act. The defendant who was charged with infringing the patent contended that the patent was invalid for the reason that the United States patent was not based upon the same invention as the foreign patent and that the Nolan Act only extended the privilege to file applications in the United States for the same invention as was patented abroad during the World War. The basis of this contention was that the claims of the United States patent were different and covered different subject matter from the claims of the foreign patent.

The Court pointed out that the foreign patent disclosed the same invention as the United States patent and held that it was unnecessary that the claims cover the same subject matter. In this connection the Court stated:

"In the Patent Office the disclosures of the foreign patent and not the claims always have been taken into account * * * The French patents disclose the invention that is set forth in the United States reissue patent."

Damages or Profits

BUSINESSMEN frequently inquire as to the measure of damages in a suit for unfair competition. In other words, when a Court determines that a defendant in a suit is guilty of unfair competition, how does the Court determine the amount of damages that should be paid to the injured party? Most of the courts of the United States, including the Federal courts, hold that the injured party is entitled to recover either profits or damages, but not both.

The profits consist of the profits realized by the infringer from the sale of the infringing article. The theory upon which this is based is that an infringer should be required to turn over his gains to the true owner upon the same principle that a trustee is required to turn over to the beneficiary any profits that he has realized by a wrongful use of the trust property.

Damages are based upon the loss of sales or income resulting from the defendant's infringement. In this connection it is not ordinarily presumed that the plaintiff would have made the sales made by the defendant if it were not for defendant's infringing acts and it is necessary for the plaintiff to prove by competent evidence that he actually lost sales or that he was forced to reduce his prices due to the defendant's infringing acts. This principle was recently reaffirmed by the Federal Circuit Court of Appeals in the Sixth Circuit. It will be readily appreciated that in most instances it is easier for the injured party to prove the profits realized by the defendant than to prove the actual damages sustained by the injured party.

Copyrighted Moving Pictures

THE Federal copyright laws do not prevent the several states of the Union from regulating the display of copyrighted moving pictures within their territorial limits, according to a recent decision of the Federal Court in North Dakota.

The state of North Dakota passed a law prohibiting the operation of motion picture theaters which are owned, controlled, managed, or operated in whole or in part by producers or distributors of motion-picture films.

A company engaged in the business of producing and distributing motion pictures brought suit against certain officials of the state of North Dakota to restrain them from enforcing the act, contending, among other things, that the law impaired rights protected by the Federal Copyright Law in that the motion pictures displayed in the theaters were copyrighted. The Court rejected this contention and sustained the validity of the North Dakota statute, holding that any remote effect that the statute might have upon the rights of the producers or distributors under the copyright law did not amount to an invasion by the state of North Dakota of the field exclusively reserved to the United States government.

Martha Washington

THE name of the first First Lady of the Land was involved in a recent suit for unfair competition brought by a candy manufacturer against an ice cream manufacturer. The candy manufacturer contended that he had used the name Martha Washington as a trade mark for candy for many years and that the defendant had recently started using the same name as a trade mark for ice cream. The candy manufacturer contended that the ice cream manufacturer adopted the name Martha Washington for the deliberate purpose of trading on the good will and reputation built up by the candy manufacturer.

The ice cream manufacturer made a motion to dismiss the suit on the ground that ice cream and candy were not goods of the same descriptive properties, were not in direct competition, and that, accordingly, the use of the name Martha Washington on ice cream did not infringe any of the rights of the candy manufacturer.

The Court denied the motion and refused to dismiss the suit, holding that in a suit for unfair competition it was not necessary that the goods be in direct competition if there was a likelihood that the plaintiff's good will would be endangered by the defendant's actions. In this connection the Court stated:

"In a suit for unfair competition, it is sufficient to show that plaintiff's good will is likely to be endangered by the defendant's use of plaintiff's name or mark. It is not necessary to allege or prove direct competition between the products of each."

SCIENTIFIC AMERICAN ADVERTISERS
November · 1938

Advertising Manager
CHARLES H STEINHART
24 West 40th Street, New York City
Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York
ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 159, No. 5, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer, I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • DECEMBER • 1938

POWERFUL microscopes are tools that find wide application in industrial laboratories as well as in the more remote corners of pure science research. Our cover illustration shows a microscope in use in the laboratory of the Chevrolet Forge Plant, where polished samples of steel forgings are examined to determine the molecular structure of steel before and after heat treating. Thus close control can be kept to assure that the heat treatment is giving the correct degree of hardness to the forging.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, December, 1938. Vol. No. 159, No. 6, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1938 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 Years Ago in . . .

(Condensed From Issues of December, 1888)

CANAL—"The telegraph brings the announcement of the financial collapse of the Panama Canal Company, due to its failure to negotiate the further sale of its bonds and its inability to meet the now gigantic calls upon it for interest and current expenses. Whether any new arrangements can be made to prosecute and complete the great work is questionable."

DYNAMITE GUN—"During the past eight years, the value of dynamite, gun cotton, nitro-glycerine, mercury fulminate, etc., for use in warfare, has been thoroughly appreciated, and the only problem to solve has been how to handle these explosives with less destruction to one's self than to the enemy. . . . In the gun which is illustrated . . . the danger of self-destruction from accidental explosion at discharge has been reduced to a minimum, as there is absolutely no shock, the shell being projected by the rotary motion of a revolving carriage. As this motion begins with a slow movement, gradually increasing in rapidity, there is no jar or shock until the projectile has been discharged and has come in contact with some obstructing object. . . . The rotatable carriage from which the projectiles are discharged consists of two steel disk wheels mounted parallel upon a shaft, which is provided with a pulley wheel for connecting it with a steam engine, or any high-power motor, by means of which the carriage may be set at a high rate of rotation. . . . The gun represented in the cut is constructed for carrying four charges at a time, each of which may be discharged in rapid succession."

BACTERIA—"In a recent paper on 'A Possible Revolution,' Dr. Austin Flint says that by a knowledge of the bacteria nearly all human ills of a physical nature may be cured or prevented."

ELECTROCUTION—"Some experiments on the effect of electricity upon animals, with a view to determining the best method of inflicting the death penalty on capital offenders, were performed on the 5th of December at Mr. Edison's laboratory in Orange."

VENEER—"The largest machine for cutting veneers in the United States is in operation in California, and shaves up logs ten feet eight inches in length with the greatest ease. The shavings which come from these machines are great, long sheets, in each of which is almost the entire wood of a big log, and from a single shaving is frequently made from 2,000 to 5,000 berry boxes."

BELLS—"Contrary to the popular idea, the exact musical tone of a bell depends neither upon the metal nor upon any change in it after being cast. If the bell should not be of the exact pitch, there is no alternative but to melt it over and recast it until the proper tone is secured. Hence, it is clear that the greatest care must be exercised, and the most thorough skill displayed."

PAVING—"The popularity of round block wood paving is steadily on the increase. A company has been formed at Mobile, Alabama . . . to put in machinery for making sapless blocks to pave the streets of that city, using juniper, cypress, and cedar. . . . Before it was decided to go into the paving business, extensive correspondence was had with residents of cities where wood paving is in use, the replies being uniformly favorable."

PLANTS—"From time to time, of late years, experiments have been made of the effect of the electrical light on flowers and plants, with results seemingly the same, to wit, feeble efforts of some plants to prolong their period of bloom into the night and then premature decay. One has only to study their actions, as observed, to conclude that even plants need rest, or, to be more precise, they seem to thrive best under the conditions which Nature has imposed."

LAUNCH—"At the American Institute Fair is being shown just now a novel type of launch, burning kerosene and with the boiler and engine at the stern of the boat. The method of firing the boiler is also new. Instead of atomizing the oil, as formerly, it is vaporized in a coil by heat, then driven out into the fire box and mixed with the air. The gas thus formed burns without smell or smoke and does not foul the tubes or sides of the boilers."

HEATING—"If some inventive genius will turn his attention to the contriving of a better apparatus for the heating of railroad cars by steam than is at present in use, he will stand a fair chance of making a fortune if he is successful. He will also save travelers from a great deal of suffering this winter, and thus earn the gratitude of the traveling public."

GAS—"People often talk of the advantages of natural gas as a fuel without having an adequate idea of its importance. It is today the greatest commercial wonder of the age. . . . It is only fifteen years ago . . . that natural gas was first used as a fuel, yet today there is required to pipe it 27,350 miles of mains. In Pittsburgh alone 500 miles supply 42,698 private houses, 40 iron mills, 37 glass works, 83 foundries and machine shops, and 422 miscellaneous industrial establishments."

TYPHOID—"The agency that milk may assume in the propagation of fatal diseases has received much attention during recent years. . . . A recent epidemic which occurred in a New Jersey suburb of this city goes far toward reducing the probability of milk acting as a disseminator of typhoid fever to a certainty."

AND NOW FOR THE FUTURE

¶Dirtless farming—complete instructions that anyone can follow, by C. F. Greeves-Carpenter.

¶Science continues its winning battle against crime, by J. Edgar Hoover.

¶Everything flows—glass, rocks, rubber and so on—the science of rheology, by R. N. Traxler.

¶Research turns mineral wastes to profit, by Paul M. Tyler.

¶Marvels of structural steel work at the New York World's Fair.

TO BENEFIT BY A GREAT DAM

CLEAR visualization of the large section of the Pacific northwest which will gain by construction of Grand Coulee Dam. This great structure, shown near lower center, is discussed on page 296. The drawing, supplied by the U. S. Bureau of Reclamation, shows a large part of the state of Washington.

Photo by Robert Yarnall Richie

A modern hospital scene. By such operations, man's life is prolonged. Perhaps, in the future, a similar photograph may be taken of a transplantation in which old organs are replaced by new. Experiments in that direction are being made on animals

MUST WE GROW OLD?

Laboratory Research by Noted Scientists Gives Ground for Some Hope that We Shall Ultimately Learn to Forestall Old Age, Even Live Eternally

By BARCLAY MOON NEWMAN

IS AGING natural, unavoidable? Outstanding bio-scientists have long taught—perhaps merely upon a foundation of guesswork—that growing old is an entirely necessary concomitant of the peculiar living chemistry called human, and that it may, indeed, be the very basis of human being. Still, there is evidence that senility is only a fortuitous companion of life.

Not all life ages. One-celled animals, such as the paramecium or the ameba, are potentially immortal. A young paramecium observed under the microscope for long periods of time is seen to fatten after a while and divide in two. True, it loses its individuality, by becoming two organisms, but it has lost no part of its vitality. Each new organism, representing a growing portion of the original animalcule, in turn divides, to transform itself into two more organisms. So it goes, indefinitely. The paramecium cannot be said to age. Indeed, the first paramecium ever to appear on earth is in part before our eyes when we peer through the lens at any paramecium whatsoever. Thus, any 20th Century animalcule is a fragment of the world's earliest animalcule, and is potentially immortal. Here, then, is earthly immortality already embodied and made visible.

Certain cancer cells also have gained potential deathlessness, though here man's intervention is needed. First, cancer is induced in a mouse by continual application (over a period of months) of any one of numerous complex organic compounds, such as 1-, 2-, 5-, 6-dibenzanthracene. Then, as one mouse perishes, the still-living cancer is sliced from it and transplanted to become the live cause of death of a second laboratory mouse. This transplanting may be kept up indefinitely.

MOREOVER, we recall that cancer, so typical of aging bodies, represents exuberant growth, so typical of youthful cells. What restraining factor, developing during the aging process, holds waxing sway over the older body, but not over this body's cancerous tissue? Here is hid a profoundly vital secret, which engages many men working to force life-lore out of lethal manifestations.

Like all higher organisms, the barnyard fowl finally dies of old age. Nevertheless, Dr. Alexis Carrel has taught men how to annihilate time's effect upon at least individual portions of the chick. From a week-old, incubating egg, cut out a bit of chick embryo's heart tissue. Avoid microbic contamination, and keep the cardiac fragment imbedded in nutrient jelly—at 98.6 degrees, Fahrenheit. The fragment grows—and grows. It must be sliced in two every few days, and the halves separately cultured—in jelly constantly renewed. Obey such rules, and the steadily proliferating tissue is thereby given man-made immortality and has forever lost all track of time. And now even human fragments are similarly be-

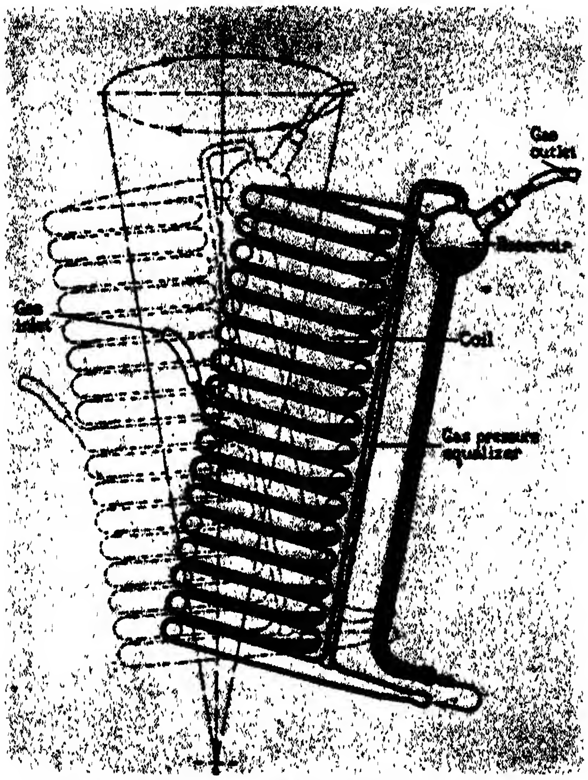
ing given laboratory agelessness—will be observable, quite alive, centuries hence.

If tissues—separate pieces of organs—are thus made ageless, why not whole organs? Today, entire organs—such as thyroid glands of cats or rabbits—are being cultured in glassware. The necessary equipment was originally described in 1935 by Dr. Carrel and Charles A. Lindbergh, and involves the "Lindbergh apparatus." This "artificial heart" pumps nutrient, oxygen-bearing fluid through the organ's blood vessels. Carrel reports: "It is certain that thyroid glands perfused in the Lindbergh pump remain alive." How long? Certainly for weeks. Minor improvements in technique should make whole organs timeless, free from age's influence, imperishable eternally—with proper care.

FROM tissue to organ to body entire—so naturally runs the train of thought. The factor of time, or age, has been removed from organ-phenomena. Logically, thought hurtles on to consideration of annihilating the temporal factor in the walking harmony of organs—the laboratory cat, and then the man in the street. Thus, Dr. William Marias Malisoff—like Dr. Carrel, eminent in experimental medicine—calls for a huge institute where all investigations upon the secret of terrestrial immortality are to be centrally organized. Concerning this proposed center, Carrel states: "The outcome of such an enterprise is not predictable. But we must remember that there is no example of a scientific search for truth which has not been rewarded."

Even the present haphazard enterprises, besides strengthening the evidence that aging is an unnecessary accompaniment of life, are in the very act of using death as a means to longer life, and therefore express more hope for the work of a future death-institute than does Carrel. Other experiments, pursued mainly by Russians, have established a new medical procedure: the use of tissues, including blood, eye-tissue, and skin, speedily removed from healthy persons who have suffered lethal disaster. Refrigeration preserves such cadaver-tissue—alive—for periods up to approximately two weeks. For more than ten years, the Moscow Institute has been transfusing conserved blood into patients, and so has saved hundreds of lives otherwise cut short. Hundreds of grafts from dead to living eyes have restored vision in some 50 percent of the trials. Though skin-grafting from dead men to live is newer, it is also proving successful. Thus, as already said, death can be—is being—used to prolong life, for a time.

Medical scientists, then, are preparing for the day when whole organs—livers, kidneys, spleens, perhaps hearts—may be transplanted successfully. But today: an organ transplanted from one warm-blooded body to another almost invariably degenerates, because it undergoes an ill-understood self-digestion or autolysis. Why? When the cause is found, and means of removing the cause is found, then old organs can be traded for new—new, healthy organs probably taken from the quickly dying.



A diagram showing the basic principles of the Lindbergh "artificial heart," an oscillating glass pump whose function is continuously to supply nutriment and oxygen to an organ in a nearby container

For bodies do not "die all over, all at once." Certain cells, tissues, or organs are killed—by accident or by disease (which may be considered accidental)—and drag the remaining body-life with them down into death's abysm of disorganization. This fact may be taken to mean that death is due solely to direct injury of a comparatively small part of the body and consequent indirect injury of the other parts.

In addition, this fact reminds us that the body does not age "all over, all at once." Like many a variety of death, aging may be due entirely to the summation of the effects of local injury—which effects glide from tissue to tissue until the whole system is turned into lethal chaos. Stiffness of joints is a common characteristic of aged people, but we all are familiar with quite old persons who are capable of athletic feats impossible for most younger persons. To age is often to bend, but every day we see old gentlemen who are as straight as ramrods. At 97, John D. Rockefeller died of an aged heart, yet other muscles were still young. In fact, nowadays most people die of degenerate—"aged"—heart, blood vessels, or kidneys—while major portions of the body are still in first-rate condition. And to be aged is not invariably to be wrinkled. If certain tissues and even certain whole organs keep their youth up to the day of death, though it be death from senility, why may not all tissues stay youthful?

There are new discoveries which give direct support to the theory that aging is accidental, the outcome of repeated local injury. Dr. William MacNider, dean of the Medical School of the University of North Carolina, has long been testing the action of poisons upon tissues of kidney and liver. Antedating his work, bio-students Whipple and Sperry demonstrated a peculiar action of chloroform. If a dog is given no food for a day, and next given chloroform by inhalation for an hour and a half, specific areas of the liver invariably perish.

THIS demonstration Dr. MacNider uses as the basis for his experimenting. With a definite quantity of uranium, he poisons a group of dogs. Some die, some survive. In the surviving animals, he finds that liver cells have been killed—but afterward are replaced by the formation of an abnormal type of cell: flat, instead of cube-like.

Dogs with such repaired livers he starves for 24 hours, and chloroforms for an hour and a half. Amazing result! Chloroform has lost its toxicity. The new cells are resistant and do not perish. Injury by one type of poison has stimulated the formation of abnormal tissue which is resistant to other types of poison. So, Dr. MacNider concludes, an organ responds to disaster by producing new cells, capable of life upon a different plane. Other experiments upon other organs verify this conclusion, and, moreover, indicate that the abnormal tissue is not as well suited to the body's healthy functioning as the old. That is, life goes on, as exhibited by the formation of new cells, yet it is life in novel guise—weird life, and unhealthy, though the best possible response to accident.

Now, MacNider continues, "A final group of experiments are of peculiar interest and importance as they take into consideration the factor of age. During the past 16 years of study in which the liver of the dog has been considered in certain experimental procedures, 24 ani-

mals have been used which may be considered senile both on account of their age, 8 to 23 years, and on the basis of certain superficial physical changes common to the senile state in any of the higher animals, including man. Nineteen of these animals have shown livers with a changed type of liver cell. The cells were not of a normal polyhedral contour, but were similar in configuration to those cells which had been made to appear as a repair process in the liver secondary to a severe injury from uranium. The cause for the occurrence of this type of cell in the livers of certain senile animals is entirely unknown.

"The question following this observation then quite naturally arose as to whether or not these atypical liver cells formed in the liver in association with the senile state were resistant to chloroform. Such animals, when starved for 24 hours and given chloroform by inhalation for one and one half hours, have shown a complete resistance against this chemical body which is certainly toxic for normal liver."

It is still more difficult to hold that senility is natural, unavoidable.

A race does not age "all over, all at once." There are always young members of the group, *Homo sapiens*. It is true that there are more extinct than living plant and animal species—millions more. Dinosaurs are extinct, but no one has been able to sustain the theory that their extinction was caused by racial old age. Belief in such a phenomenon as racial senility has no scientific basis.

So, in a remarkable sense, immortality on earth is already associated with—nay, clearly an attribute of—human life. For some 1,000,000 years, the human hereditary material—the human germplasm—has been transmitted from generation to generation and has endured unaging. In truth, for some 1,000,000,000 years, the life-stuff of which man is part has survived. And, in this billion years, not a break has there been in the flow of live plasm, no least halt in vital activity. Even now, at least part of the human life-substance transcends time.

Guesswork has asserted that the rhythm of reproduction is essential to lasting racial youth. It is hazarded that such periodic offspringing induces rejuvenation of the racial plasm. Yet concrete evidence is entirely wanting. It may be that reproduction must *naturally* precede rejuvenation—always; or be *naturally* a first procedure in the maintenance of racial youth. Still, the establishment of such a natural necessity would not preclude the possibility of the development of *artificial* means for staving off senility. And senility could still be a mere artifact of high-plane life. At any rate, we have this unforgettable information: the germplasm, at least a part of the human life-stuff, already transcends time—however dark our ignorance of this notable power.

Certain seekers after bio-secrets think that we have made a start—though surely an almost insignificant start—upon the immense problem of artificial rejuvenation. Not only have cells been made deathless in laboratory glassware, but also cells which have ceased to grow in the tissues of an aging body have been stimulated to youthful multiplication. In the test tube, adult tissue immersed in juice from very young tissue remains for a time dormant, but after this lag period surges to fresh growth. Apparently, older tissue has accumulated within it chemical growth-inhibitors which a stimulant derived from young tissue can overcome. Tests, too, show that extracts from aging tissue retard the growth of young tissue maintained in laboratory ware. Further, Drs. Henry S. Simms and Nettie P. Stillman, of the College of Physicians and Surgeons, at Columbia University, have demonstrated that partial digestion of adult tissue with the well-known digestive ferment, trypsin of pancreatic juice, cuts short the lag period. Trypsin, it is thought, disintegrates the growth-inhibitors, and thus represents a very primitive means towards artificial rejuvenation. These investigators have found that blood's liquid fraction—plasma—also has a stimulant capable of shortening the dormancy of adult tissue, and that it is not trypsin or a related ferment—but an unknown substance, termed by them the "*A* factor." In the absence of this mysterious factor, no growth occurs.

Seven live specimens of paramecium, a microscopic water-dwelling organism which is potentially immortal. Often called also the "slipper animalcule"

AND in November, 1937, the discovery of a growth-promoting substance of the most dreadful potency was reported by Dr. Leonard Rowntree, director of the Philadelphia Institute for Medical Research. This substance is obtained by crushing wheat embryos and mixing the crushed material with ether, whereupon the potent stimulant goes into solution in the ether. Such extract, fed to albino rats, releases growth-inhibition of cells invariably of the abdominal cavity, and causes them to multiply wildly—so wildly that tumors, always fatal, take rise. Dr. Rowntree adds: "These tumors are transplantable in practically 100 percent of the cases. The implants retain the characteristics of the primary tumor through as many as 20 hosts. . . . Some progress has been made concerning the nature of the tumor-producing substance. . . . The new tumor-producing substance is apparently more active than any other known cancer-causing agent, in that it produces tumors more quickly. Because this is the first time that feeding a plant product has resulted in tumor formation, we are attempting to explore thoroughly the possibilities of the relation of vegetable embryos to tumor production." Other cancer-causing—growth-promoting—compounds have for years been studied. Most of these are coal-tar derivatives. As yet, however, no inkling has been gained regarding the mode of action of any cancer-inducing chemical. Nevertheless, work with such molecules confirms the thought that growth—youthful multiplication—may be, probably always is, chemically regulated. And however uncontrolled, however fatal, is proliferation thus stimulated, none can deny that a return to one significant feature of youth—rapid growth—is today a definite laboratory triumph. Future tinkering with the physical chemistry of the growing cell ought to bring other triumphs. Some aver that the secrets of cancer and of youth are one.

Beyond achievements in artificial rejuvenation and in turning tissues immortal in laboratory glassware, there are demonstrations wherein undismembered animals are made less dependent upon time. Here is one more hint that aging is accidental, not grimly, irredeemably yoked to time in flight. The span of life can be lengthened—longevity can be modified by environmental changes: changes in degree of activity permitted and in nutrition.

Using more than a score of thousands of mice, and several consecutive generations, Carrel has exhibited the different effects of a sheltered life and a free life. Sheltered mice are forced to lead an existence of quiet, inactivity, and regularity. Free mice are free to scamper, fight, burrow, and multiply at will—as a community. To mice, a protected life means an increase in longevity of approximately 34 percent.

Following in the footsteps of many other workers, Carrel shows that diet,

too, makes a difference. On lean fare, life is prolonged approximately 17 percent. Other diets—in which the proportions and types of food are varied—seem to increase (or decrease) the life span by as much as a third. He therefore can state: "Longevity, though being a hereditary tendency, can be artificially modified in large measure. Therefore we are not forbidden to hope that a wise handling of environmental agencies may lead to the prolongation of our existence."

As regards nutrition, the latest findings of Dr. Henry C. Sherman, of Columbia University, are yet more noteworthy —since far more exhaustive researches pursued through decades have turned them up, and since they point to definite molecules definitely reacting upon the aging process. In December, 1937, he and his collaborator, Dr. Lillian N. Ellis, fascinated a New York City symposium on vitamins:

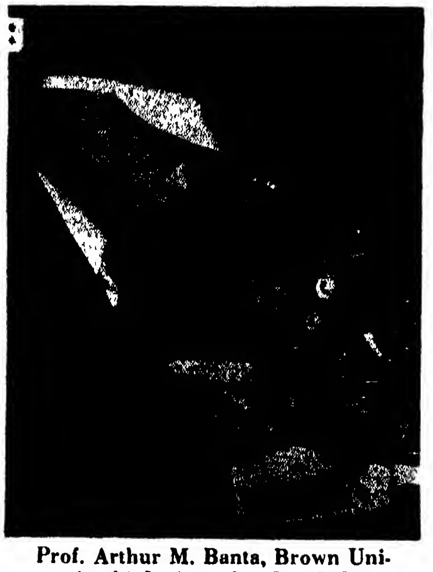
"FOR the past five years, Columbia University, with the co-operation of the Carnegie Corporation of New York and the Carnegie Institute of Washington, has studied the question of optimal as distinguished from merely adequate intakes of several nutrients—including the substance which until recently we called vitamin G and now known as riboflavin, an important factor in good tissue condition and vitality in the body.... When these tentative findings of experiments still in progress with riboflavin are interpreted in connection with those of work upon calcium and other factors in the hands of Drs. H. L. Campbell, R. T. Conner, and C. S. Lanford of our laboratory, and the work with vitamin A by Dr. E. L. Batchelder, formerly of the same Columbia research group, it appears that food-chemistry conditions the life process to a more significant degree and in a more far-reaching way than has hitherto been supposed.

"Thus it is found that differences in the relative proportions in which we choose and use our everyday staple foods may make sufficient differences in the body's internal environment to influence measurably one's well-being, especially when such differences are continued throughout a lifetime.

"Experiments just completed in this laboratory indicate that calcium, vitamin A, and riboflavin or vitamin G are all concerned in the increased length of life which results from better adjustment of the relative proportions of food in an already adequate diet. The separate influence of riboflavin is now being studied upon the entire life cycle."

So Sherman and his colleagues upset the venerable hypothesis that chemistry of rat—upon which they experiment chiefly—or chemistry of man is fixed, with longevity fixed. Through generations of newer feeding methods, rat or man can be urged to greater longevity. The newer feeding has forced rat generation after rat generation to steadily lengthening life-spans. And the chemistry of rat is very like that of man: the precise reason why the rat is studied intensively. Meanwhile, milk—ever recommended as a good food—begins to show up as a still better dietary item: it contains calcium, vitamin A, vitamin G.

Both Sherman and Carrel realize that



Prof. Arthur M. Banta, Brown University biologist, who doubled the life span of tiny marine animals (Daphnia) by feeding them little in youth, generously after maturity

heredity is a basic factor in longevity—or at least apparently so. That is, man characteristically lives less than 100 years. Yet both bio-scientists show that inherited tendency toward senile death at a given age is no more than a tendency, subject to modification—especially if successive generations are tampered with. And what, at most, is heredity? It is a definite physico-chemical mechanism—machinery that the laboratory can already adjust, repair, accelerate (negatively and positively) and turn to new ends. Of course we know excessively little of such techniques. The point is that the laboratory has made a beginning. Indeed, novel artificial plant and animal types even thus early prove that evolution can be man-handled. Evolution is day by day altering heredity.

Is there not, in fact, evidence that to age is to meet with accident? Has not old age entered the laboratory to manifest itself more and more clearly as a phenomenon which intelligence—by science —can learn to forestall? A few speculative scientists hint as much. It may turn out that death by old age, today a certainty for those who live long enough, can tomorrow be made uncertain. There is no scientific reason why the imagination should flinch at the thought of reducing the odds favoring fatal outcome of life activity. During the past century, a score of years has been added to the average duration of civilized human existence, while experimental animals have even had their apparently fixed heredity, with apparently fixed life-span, shifted into new patterns. It is not altogether wild to guess that, already in 1938, the newer knowledge of vitamins and their consequent more efficient use will later be recognized to have stretched human longevity. Besides, where is the scientific evidence that aging is actually necessary?

In honesty, however, it must be admitted that, though we talk of and experiment with phenomena of senility, we do not know that of which we speak or that with which we deal. After all, what is senility? The truth is that nobody knows. We are reasonably sure that certain phenomena—wrinkles, physical and mental deterioration—usually become evident after an uncertain number of years. We are reasonably sure that the longevity of animals, perhaps including man, has been increased artificially. But now we are starting to think of aging as possibly accidental. Nevertheless, there is no scientific definition of old age—no unscientific definition without so many qualifications as to be meaningless.

CARREL suggests that, since the wounds of old men (often) heal slowly: "The measure of the physiological age of the body, as distinguished from its chronological age, is its regenerative activity (as in the healing of a wound)."

Next he considers the relation of growth of tissue to type of medium in which tissue is cultured in the laboratory: "Age can also be detected by certain changes that take place in blood plasma. We found that, under certain conditions, plasma has a restraining effect on the growth of cell colonies. This effect increases with age."

Other scientists do not entirely agree. There are many exceptions to Carrel's proposed rule of aging. Many a man, surely to be called old both in years and in appearance, can boast of quick-healing wounds. And the body does not "age all over, all at once"—which fact is to be admitted, whatever definition of aging is chosen. Perhaps not even individual, microscopic cells age "all over, all at once." No, the essence of senility is completely obscure. The years eventually, relentlessly, transport us to death—a peculiar sort of death, only to be told of in vague, popular, rule-of-thumb terms: death by old age.

And what is death? This, too, we do not know. We cannot define dying, because it is the negative of living, an unknown. Dusty ages ago, men became aware that life and death are a single mystery. Behind the veils secreting the shape of life is death too, including death by old age. Will man, in ages to come, pierce these veils? Who knows?

OUR POINT OF VIEW

Peace

WHAT a sorry sight this earth has been during the year now rapidly drawing to a close. Individually and collectively the peoples of the world have behaved very badly indeed. Spain is still involved in a blood-letting orgy which provides the stage for war rehearsal by outside nations and a training ground for their soldiers. In China there is constant enlargement of the "incident" in which Japan has killed hundreds of thousands of Chinese and destroyed the homes of millions. The year in Europe has seen the rape of nations by what has been called the new "stand and deliver" diplomacy, the scornful destruction of many treaties, and the humiliation of nations proud and powerful. Yet there is peace between all nations—peace at what a price! And how enduring!

From a distance, we can look upon the scenes of man's infamy with a certain degree of equanimity. To many of us there was evident in the European crisis not only a great deal of machiavellian bluff and a quite general horror of war based on tragic experience, but also a superabundance of fear on all sides. Each nation feared the might of its prospective antagonists; and each side, having enormous benefits to gain by a war victory, was more afraid of defeat than of war itself. So it seemed to some people. All the nations had armed well but each was deficient in some important detail. Hence the bluffers were successful despite their own national deficiencies that might have led to disaster even in a short war. The world may, therefore, rest easy as Christmas approaches, for the general European war has been postponed—for how many months no one dares predict.

Hearing the United States called "the most powerful nation in the world"—as praise was given us for the President's notes pleading for negotiations instead of war—should serve to cause deep reflection in this country. We want no further material participation in Europe's quarrels, we covet no part of another nation, and we will not fight when honorable diplomacy can settle any differences we may have with another. Yet as "the most powerful nation" it behooves us to keep others afraid of us. By building our military forces both in size and efficiency, we may yet become a powerful influence toward that permanent world peace all have sought for so long. By a strange perversion of human nature, that influence on other peoples would not be due so much to fear of our military prowess as to a desire to follow a mighty leader in the cause of peace and justice. If this may sound egotistical, think back to post-war days when our world's mightiest fleet so roused the nations that the naval disarmament treaties came into being. A similar situation and an equally praiseworthy result can be predicted if we work toward consummation of that ideal.—*F. D. M.*

Steam Again?

FROM New England come reports that experimental work is well under way with efficient steam power plants for automobiles. Preliminary investigations show a sincerity of purpose and an aversion to premature publicity that augur well for the future of the endeavors.

Most of our readers are undoubtedly familiar, at least in a general way, with the early steam automobiles. That these cars had faults cannot be denied and, with the major part of automotive engineering efforts directed toward the development of the gasoline engine, they dropped by the wayside mourned not a little by those who had driven them and were familiar with their many fine points. On the credit side of the old steam car ledger must be placed smoothness of operation, acceleration, power, and extreme simplicity of control. On the debit side were matters of insurance and local ordinances directed at steam power plants, the aversion of the timid to "sit over a steam boiler," the loss of steam pressure at critical moments, and so on.

Technical knowledge has come a long way since steam automobiles were in general use. We have new alloys, new materials; research in fields other than automotive has added greatly to available data on fuel combustion and boiler design. The home-heating oil-burner, for example, has reached a high point of perfection, and may have lessons to teach the designer of steam automobiles. What possibilities lie in a motor car that efficiently burns low-cost fuel oil to operate a flash boiler of refined design!

It takes an unlimited supply of optimism, courage, and technical knowledge to enter the automobile field with a "new" type of car and to compete with the sleek, smooth-running, powerful gasoline cars of the present day. But the possibilities of success are great if engineers are permitted to follow unhampered the logical paths toward technical perfection. In the field of steam lie possibilities of the simplicity of control that gasoline-car engineers are striving toward, but from which they are seemingly barred by the uncompromising relationship between torque and revolutions-per-minute of the internal combustion engine. The steam car needs no clutch, no gearshift. A throttle and a brake system, plus steering control, is all that the operator needs when on the road.

There is no doubt that a modern steam car can be built to overcome many if not all of the undesirable features and faults of the earlier vehicles of this type. Both the public and the automobile industry will profit if a successful steam car is introduced in this country. The intelligent competition which it will offer to the gasoline-driven motor car will react to the benefit of all—to the steady improvement of our present-day well-nigh perfect passenger vehicle.—*A. P. P.*

Let's Keep Cool

WHO among Europeans first discovered America? As has been pointed out by *The New York Times*, it detracts none from the credit due Columbus that Leif Ericson of Iceland arrived 492 years in advance of the Italian, since the Scandinavian found our continent by accident while Columbus knew exactly what he wanted, sought it and found it.

But now anthropologists and historians are offered evidence that other Scandinavians followed Ericson in the same century. An iron sword, an ax, and a shield handle stated to have been found 50 miles north of Lake Superior by a prospector and purchased by the Royal Ontario Museum are regarded as 11th Century workmanship. J. W. Curran, editor of the *Sault Daily Star*, Sault Ste. Marie, Ontario, has sent to scientific societies and periodicals a series of articles seeking to show that Scandinavians entered Canada by way of Hudson's Bay, and a bitter debate is likely to follow. This happened in the case of the Kensington Stone from Minnesota bearing evidence (if genuine) that a party of Scandinavians traversed that area in 1362. In that super-heated dispute scientific objectivity was sacrificed—almost lost sight of. Passions thus strongly aroused practically preclude a judicial weighing of evidence; people take sides instead and stubbornness supervenes.

It is therefore to be hoped that, as the more recent finds having similar purport are weighed, this kind of heat with too little light will be omitted. It would have been remarkable if the Icelandic colonists in Greenland, in the course of several centuries, did not enter Hudson's Bay and points south, not once or twice but repeatedly, and fresh finds are likely to turn up in future years. Our passions will not help us learn the truth; they obscure it.—*A. G. I.*

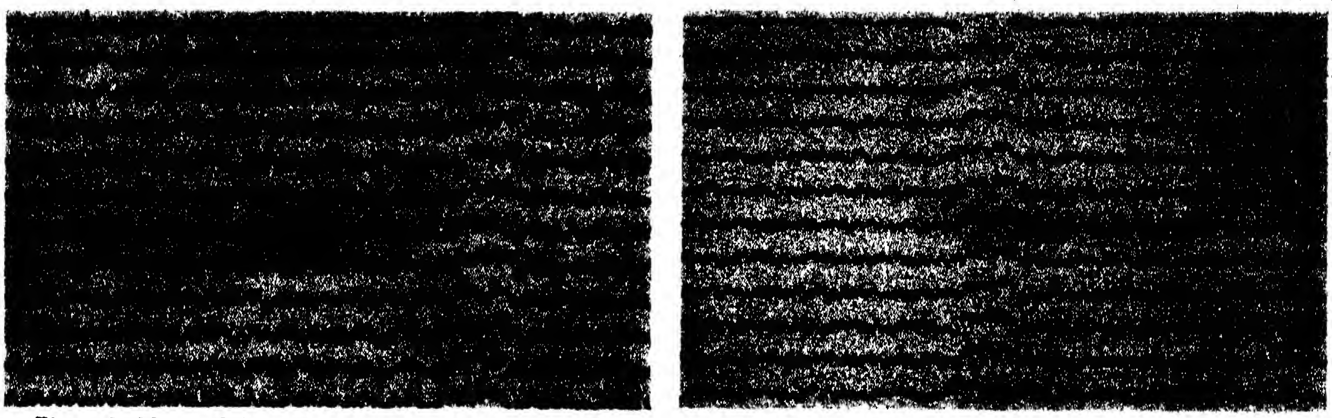


Figure 1: **The earth beneath New York pulsates constantly, due to pounding of the surf, blasts, occasional distant quakes, and traffic. The traffic factor is contrasted in these two records, the one at left for Saturday night, that at right, Sunday morning**

THE EARTH'S PULSE

How the Scientist Goes About the Interpretation of the Wavy Lines—Signatures of Earthquakes—Recorded on the Moving Drum of the Seismograph

By REV. JOSEPH LYNCH, S.J.
Director of the Seismic Observatory, Fordham University, New York, N. Y.

FIGURE 1 looks like a cardiogram. It is a cardiogram—a cardiogram of the earth's pulse at New York. It is the daily record of the vibrations of the ground under New York City and may be taken as a typical cardiogram of the ground under any large city. Some of the vibrations are caused by traffic, some by blasts, some by earthquakes and some by what we might call the natural heart-beat of the earth. However, if there were no traffic in New York and no inhabitants within miles of it, the ground would still have a certain throbbing—a continuous pulsation much like the heart-beat in the human body. The full cause is not known but the generally accepted cause is the action of the surf on the coast. The surf transmits to the ground a rhythmic vibration which is felt over the entire continent. The normal pulse of the ground under New York due to this surf action is about 33; that is to say, these natural throbs or microseisms occur at the rate of about 33 to the minute. Longfellow might well have been describing microseisms when he wrote

"My soul is full of longing
For the secret of the sea
And the heart of the great ocean
Sends a thrilling pulse through me."

WHEN the milk train is rushed into New York in the early morning, the New York pulse quickens in expectation and rushes to the alarming figure of about 200. The ground within an area of several square miles of the train pulses at the rate of 200 vibrations a minute. A distant quake in India nearly trebles the earth's pulse here in New York. A sudden cough or blast, such as might be caused by a few hundred pounds of dynamite being discharged in the earth's rocky gorge, would increase her pulse to about 60.

In a previous number of Scientific American (August 1936, pages 88-90) a description was given of the cardiograph which writes these cardiograms of the earth's pulse, the most sensitive seismograph yet developed—the Benioff seismometer devised by Professor Hugo Benioff of the California Institute of Technology. Briefly, the seismometer consists of a heavy horseshoe permanent magnet (Figure 2) with two soft iron pole pieces attached. Coils are wound around the pole pieces. The weight of the whole is about three quarters of a ton. This heavy mass constitutes the pendulum and is suspended from a spiral spring so that the pendulum oscillates vertically. The magnet supplies magnetic lines of force to the pole pieces. Under these pole pieces and attached to the ground is a soft iron bar through which the magnetic circuit is completed. An air gap of one millimeter separates bar and pole pieces. A vertical thrust in the ground caused by a quake changes this gap and consequently changes the magnetic flux through the coils. This starts a current through the coils, which are connected to a galvanometer. The mirror of the galvanometer, by reflecting a light beam to photographic paper on a recording drum, finally records the earth's thrust.

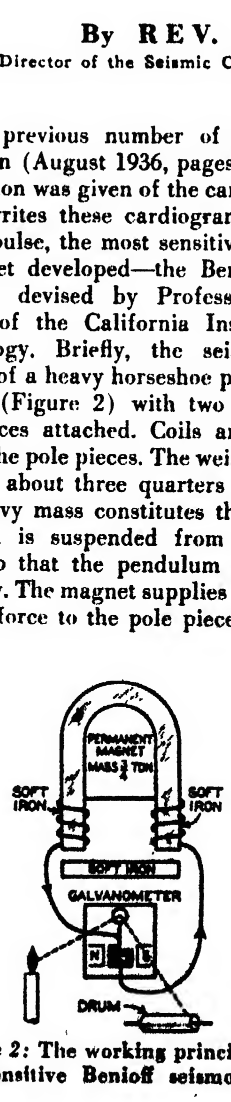


Figure 2: **The working principle of the sensitive Benioff seismometer**

IN the present article, we propose to show some of the unusual and interesting disturbances recorded at Fordham University by this supersensitive seismograph. Paradoxical as it may seem, the chief victims of this Benioff "earthquake trap" are local disturbances and the beginnings of very distant ones. Local quakes and the beginnings of deep-seated distant ones are alike, in that they are of short period. Hence the very short period (one half second) and high magnification (100,000) at short period (the magnification of any seismograph depends on the period of the earthquake wave it is recording) make the Benioff vertical seismograph especially suitable for detecting these two types of earth disturbance.

In the cardiogram in Figure 3 we have recorded side by side a New York Cen-

tral milk train and a distant earthquake which shook the Hindu Kush Mountains in India and, incidentally, stopped a cricket match which was in progress in Lahore. This double record is almost as incongruous as having the swell of the Pacific and the ripples of a swan on Central Park Lake felt equally by a person atop the Empire State Building. But, apart from this incongruity, this partic-

Figure 3: Above 1 is the record of an earthquake in Asia, pulse 60. Near 2 is that of a train, pulse 200. 3, 3, etc., microseisms, pulse 33

ular quake has a special interest for us. It gives an example of a phenomenon in seismology, the nearest analogy to which would be that of double refraction in optics. If we examine the print of this page through a piece of Iceland spar we see a double image of the print. This double image is due to the fact that the Iceland spar doubly refracts the light and each refraction gives us a separate image, as Figure 4 shows. Something similar to this double refraction occurs in seismology. Under certain circumstances, when a wave strikes the core of the earth, it is split up into two waves, as the Iceland spar splits up the light wave. One of these waves is refracted into the core while the other is diffracted 'round it. In Figure 5 two of these transverse earthquake waves have been plotted by the author for the Hindu Kush quake just mentioned. The curves were plotted with the aid of records of this quake borrowed from observatories all over the world. The waves were identified on each record and the time of arrival measured. The curves were then drawn by plotting distance of observatory from quake against time of arrival of phases at observatory. It is only in comparatively recent years that the double effect has been known in the case of transverse waves. Up till then the refracted wave (which is the stronger of the two) was misinterpreted as the ordinary wave, the travel time of which is quite different. This led to errors in the distances of quakes for stations where the double phenomena existed. Since seismology as an exact science is little more than twice the age of the now famous race horse Man o' War,

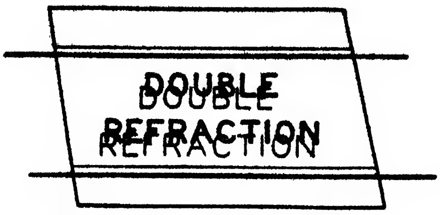


Figure 4: How Iceland spar acts on a ray of light—double refraction

we must not be surprised that the various phenomena of earthquake waves are only gradually being discovered.

A recent disturbance of interest, recorded by the seismograph, was the explosion in the Horton Brewery in New York City, six miles away from the seismographic station at Fordham University. The explosion seems to have been definitely established as a dust explosion—a spark igniting some pitch dust near the pitch fuel hopper. The center of the explosion was in a room about two stories above ground level. As shown in the picture (Figure 6), the whole side wall of the building was blown out. The effect of the explosion on the ground underneath was that of a sharp but tremendous blow which sent ripples or earthquake waves traveling

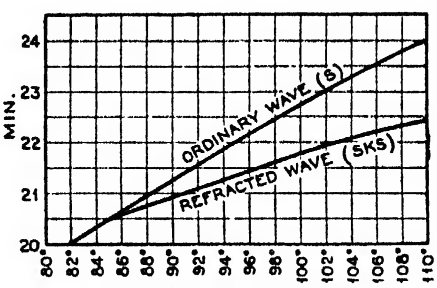


Figure 5: The ordinary and the refracted wave, plotted. See the text

through the earth. There were two such ripples and they reached Fordham just one second apart, though they started out from the brewery together. The first ripple was a compressional or sound wave in which the earth particles were pushed ahead or compressed longitudinally, as are the air particles in an organ pipe. The second ripple was a transverse wave in which the earth particles were shaken from side to side, or up and down at right angles to the path of the wave—like the flapping of a bird's wings as it flies forward. If one should strike a bar of steel or any solid a blow at one end, two such waves—a compressional and a transverse—would travel along the bar and the compressional will always travel faster than the transverse. These two waves are due respectively to the elasticity of volume and the elasticity of shape of the steel or solid. Their velocity depends only on the material of the bar—not on the force of the blow but, as already mentioned, no matter what the material, the compressional wave travels faster than the transverse. It took the compressional wave about two seconds to travel the six miles from the brewery to our observatory. It took the transverse wave about three seconds. In the record reproduced (Figure 7), the beginnings of the compressional and transverse waves are marked and will be found to be about one second apart. Allowing for the clock correction, the actual times of arrival of the two waves at Fordham were 01.24.06 and 01.24.07, Eastern Standard Time.

THE next disturbance in order of interest was something very much farther away—the violent Banda Sea earthquake of February 1st, 1938. This earthquake was so violent that the waves or ripples it gave rise to apparently traveled back and forth through the earth several times. The Benioff instrument at Fordham recorded one such wave which started at the Banda Sea just north of Australia (Figure 8), traveled through the earth to a point almost opposite (166 degrees away to be precise), was reflected from the inside of the earth's crust at this point much as a light wave would be reflected from the surface of a concave mirror, back through the earth to a point not far from the Banda Sea (166 degrees away) and again reflected at the inside of the crust back to Fordham where it was recorded by the Benioff seismograph. On the record (Figure 9), *εP'* indicates the arrival of the compressional wave which traveled directly by the shortest path through the earth from the Banda Sea to Fordham. *P'P'P'* indicates the compressional wave which arrived some 45 minutes later, after having traveled three times through the earth as just mentioned.

But how do we know that the wave

Figure 6: The source of the waves recorded in Figure 7 was a dust explosion in this building

Figure 7: **A detailed study of a record that was made at Fordham, six miles from the source**

recorded followed such a path? We do not know with absolute certainty, but if a house has been burgled and finger prints have been found on the window ledge, the man whose fingers match the prints may reasonably be suspected of the burglary. The finger print left by this particular wave is the time it took to reach the observatory. When a boy arrives home from school an hour or so late one suspects he did not come straight home. So, when a compressional wave from the Banda Sea arrives here 45 minutes late, we suspect it did not come here directly. We know it was a compressional wave, from its period and certain other characteristics. We know the velocity of the compressional wave through the earth with fair accuracy from repeated observations. Hence the problem is: given the velocity of the compressional wave and given that it takes 65 minutes to travel from source to observatory, what path did it follow? The direct compressional wave, that is, the compressional wave taking the shortest possible path from quake to observatory (140 degrees), took slightly less than 20 minutes. How are we to account for the extra 45 minutes taken up by the second wave? The most likely, though not the only explanation would be that the wave, as in the diagram, struck a point on the inside of the earth's surface 166 degrees away from the quake. Here it was reflected to a second point 166 degrees farther away and was again reflected from here to Fordham.

"But how did you hit on 166 degrees?" someone asks. Fordham is 140 degrees away from the Banda Sea. If we add one complete circumference, 360 degrees, we get 500 degrees, and if we divide this by three we get 166 degrees, approximately, so that a doubly reflected wave going the long way 'round and reflected at intervals of 166 degrees would strike the earth at Fordham, and this path would afford the errant wave more travel time than would any other path with two reflections. Introducing a third reflection would delay the wave altogether too long, whereas a single reflection would be far too short.

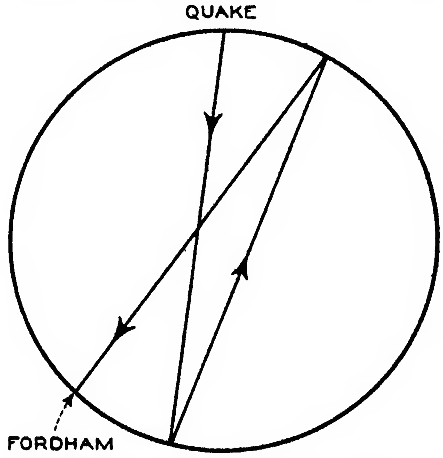


Figure 8: **Some of the more violent earthquakes bounce back and forth**

The time taken for such a doubly reflected wave would be 63 minutes, still a trifle shorter than our wave actually took —but the difference may readily be put down to our uncertainty of the absolute value of the velocity of the compressional wave over the path traveled. In the record shown in Figure 9, the wave discussed is seen to be quite distinct from the regular surface waves (the long sinuous waves) which travel around the outside surface of the earth, like waves on the surface of the ocean. They travel at a speed of about two miles an hour, less than half as fast as the body wave. Such triply reflected body waves have been observed and identified before, but never at such great distance. Hence the element of uncertainty in positively identifying the wave, but the evidence at hand seems to point to its being such a triply reflected wave.

Usually one associates earthquakes with the equator and the Pacific Basin, but our next and last record of interest takes us down near the South Pole. It is the record of a quake which occurred a little south of where Shackleton had to abandon his doomed ship, *Endurance.* On Saturday, August 8, 1914, Sir Ernest Shackleton sailed from Plymouth in the *Endurance*, hoping to be the first to take an expedition right across the Antarctic continent. On October 27, 1915, his ship, after having been locked in the ice for 281 days and drifting helplessly with it some 507 miles, was a victim of the ice pressure and had to be abandoned. She was crushed, literally, to splinters. Some miles south and east of where she was crushed in the Weddell Sea, on January 24, 1938, a very severe earthquake occurred, a record of which is shown in Figure 10. The unusual feature of the quake is its icy location—the only one ever recorded in this part of the Antarctic. It apparently occurred in the bed of the Sea.

No story, not even an earthquake story, is complete without a moral. As the duchess said to Alice in Wonderland, "Tut, tut, child, everything's got a moral if only you can find it," so we'll close with the lines on the observatory clock:

> "Do not squander time.
> For of all sad words
> of tongue or pen
> The saddest are these:
> 'It might have been.' "

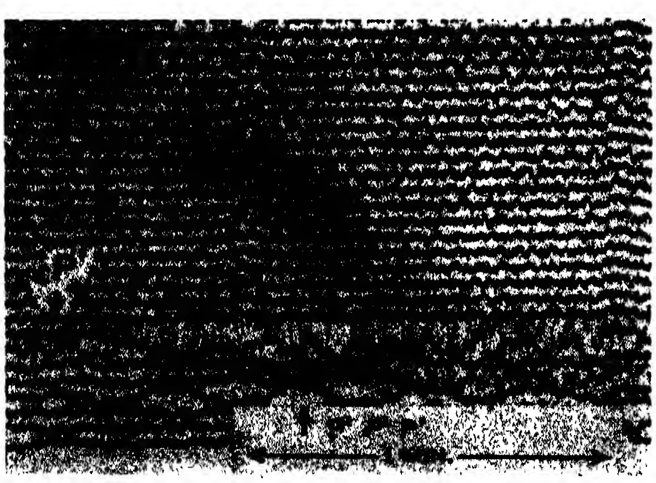


Figure 9: **How an earthquake that occurred in the Netherlands East Indies recorded itself twice in New York City**

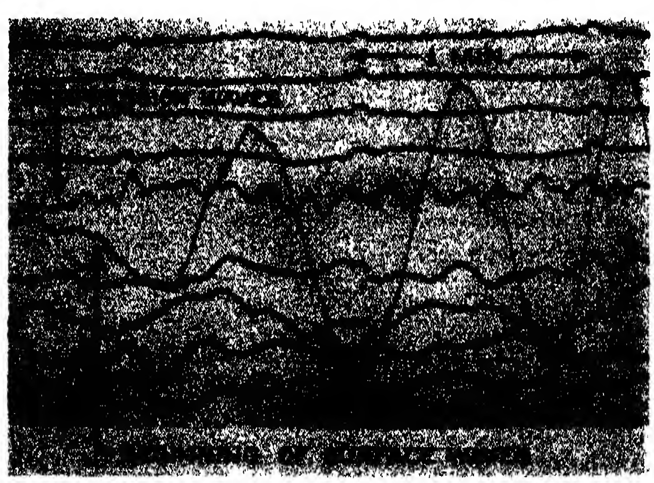


Figure 10: **A study of the record of an earthquake that occurred near Antarctica, far southeast of South America**

INDIAN PETROGLYPHS

Idle Scribblings?

CARVED and painted on the smooth faces of cliffs and boulders over most of the United States, but particularly in the Great Basin and the Southwest, are crude geometric designs and pictures of animals which are unquestionably of Indian origin and of considerable antiquity.

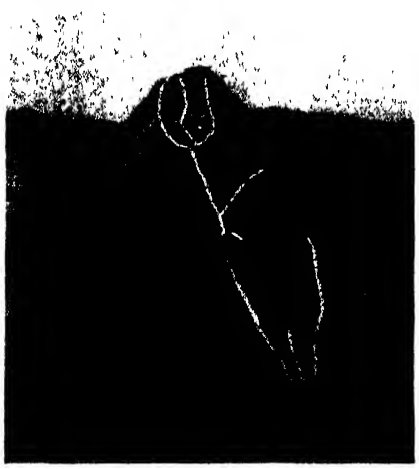
The Bureau of American Ethnology of the Smithsonian Institution states that it receives many inquiries concerning the meaning of these, but seldom is able to give any valid answer. Many theories are advanced to explain particular "petroglyphs." Many, totally unfamiliar with Indian ways of life, believe that they are cryptograms containing directions for finding buried treasure. These often are badly disappointed when told that the North American aboriginals attached no value whatsoever to "treasure."

Some believe that these petroglyphs constitute a lost written language in which the lore of the ancients was recorded, and that eventually somebody may find a key to this language. This is just as far-fetched as the first explanation. No North American tribe came any nearer to writing than the drawing of crude, realistic pictures of specific events —a practice which reached its highest development among the Plains Indians.

STILL others believe that they can see in the pictures the forms of European letters, and attribute them either to pre-Columbian white men, such as the Northmen, or to ancient invaders from the "lost Atlantis." Such assumptions are purely gratuitous. Actually the subject of Indian "rock writing" has not been sufficiently studied and only a few generalizations can be made about it. One of the chief studies has been made by Dr. Julian H. Steward, of the Smithsonian staff. A good many of the petroglyphs, he believes, represent just idle scribbling; others are representations of religious objects; still others may have been intended to describe events, and some may have been drawn to give directions.

In favor of the "idle scribbling" explanation, Dr. Steward says, is the fact that since the coming of the white man Indians have made hundreds of petroglyphs of men, horses, railroad trains, houses, boats, and other objects of civilization. He says: "In view of the great trouble which white men frequently take to deface rocks and trees with names and initials, especially where other persons have done so before them, it would be foolish to suppose that the motives of the prehistoric Indians were not sometimes equally trivial. It is a safe guess that a large number of petroglyphs were produced by persons amusing themselves during dull hours.

"Many pre-Columbian petroglyphs, however, must have been made for some definite and important reason, else the designs in each area would not conform



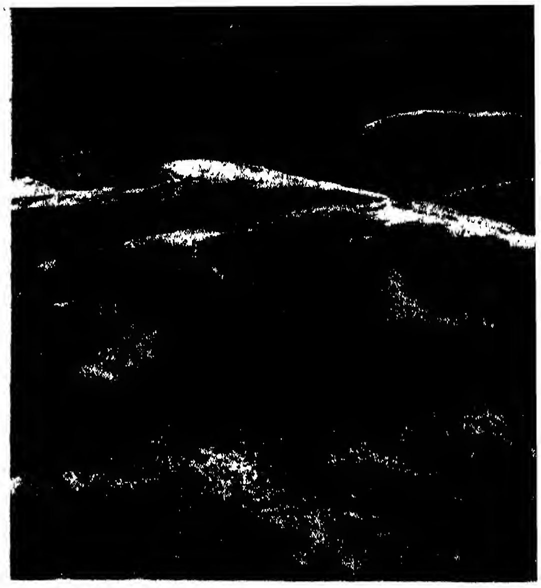
Petroglyphs—Susquehanna River

in such large degree to a prevailing style and would not have been worth the immense labor often required to make them. The testimony of modern Indians concerning petroglyphs is extraordinarily disappointing. They know of them as landmarks and sometimes believe them to have had a supernatural origin. But even where there is good evidence that the glyphs were made by the tribes now inhabiting the area, the practice seems generally to have been abandoned at the advent of the white men and most knowledge of them promptly lost. The explanation of this is undoubtedly that they were generally of interest only to the persons who made them and the knowledge died with these persons."

Many were made for religious purposes, Dr. Steward holds. The primitive Indians believed in many supernatural forces whose favor must be won. A god may be more successfully supplicated if his likeness is present. People the world over made wooden and clay images of their gods. Many of the rock pictures presumably were of this nature.

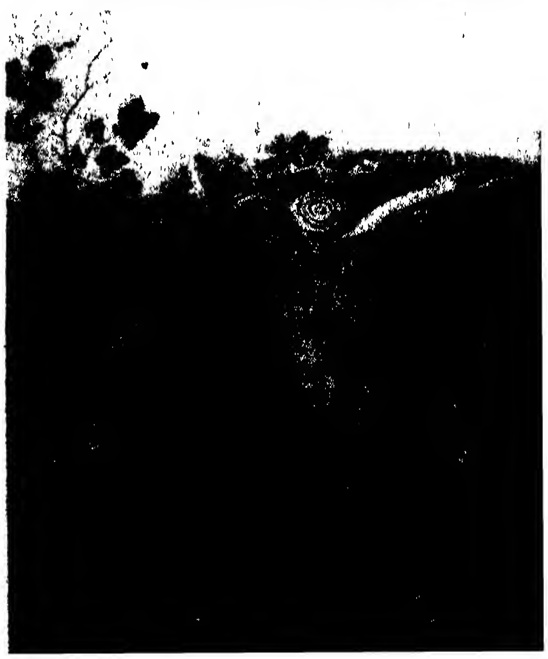
Some of the rock figures are undoubtedly very old. Now and then it is claimed that some one of them represents a now extinct species of bird or animal. Sometimes it is even declared that pictures of dinosaurs are found—an utter impossibility because the last of the monsters disappeared almost 100,000,000 years before the first men appeared on earth. That some of them might be intended to represent the mammoth, or an extinct variety of bison or camel, is by no means impossible, although quite improbable. Thus far none of these claims has been satisfactorily substantiated.

It is easy enough with a little imagination to detect forms of European letters in petroglyphs. It would be remarkable if there were not such coincidences. Isolated ones, of course, have no significance and nothing else of this sort has been found. Some of the rock paintings are clearly fraudulent, designed to draw the attention of the public to some particular place. On the whole, however, Dr. Steward urges persons running across such rock drawings to photograph them. What is without meaning now may fit into a comprehensive pattern later.



Petroglyphs—Arizona, 50 miles from Tucson

Petroglyphs—Maryland. (They are widespread)



INSIDE THE

There is Evidence that Matter Within Some of the Greater Planets Exists in Forms and Conditions that Would Seem Bizarre to Dwellers on Our Earth

THE astrophysicist has usually to deal with very hot matter—for the very good reason that only incandescent bodies are visible at even the smallest stellar distances. There are some interesting exceptions—the huge dust-clouds which form the dark nebulae, the masses of rarefied gas which shine in other nebulae, and the far more tenuous distribution of isolated atoms which produces interstellar spectral lines.

Within our solar system, however, and apart from the Sun itself we have to do only with cold—or at least, cool matter, and our methods of investigation are different.

The spectroscope, though still an invaluable aid, tells us less in proportion, not because of any inherent limitations of its own but on account of our own situation. Could we observe the whole range of the spectrum we would find that every constituent gas in even a cold atmosphere would reveal itself by characteristic absorption lines. But we have to look up through a great ocean of gases above us, and these absorb so powerfully that the whole ultra-violet region, except for a small part close to the visible, is utterly cut off. There is heavy absorption, too, in the infra-red, and it's only in the range which our eyes can see, and a little beyond it, that the earth's atmosphere can really be called clear.

THE characteristic absorptions of many abundant gases—hydrogen, nitrogen, helium, and neon, for example—lie entirely in the inaccessible ultra-violet. Other important molecules—oxygen, water-vapor, carbon dioxide, ammonia, methane—show up in the accessible spectral region. But, in all cases, the absorption of the observable bands is very weak—roughly from a thousandth to less than a millionth part as great as for the characteristic lines of atoms in the Sun, so that only abundant constituents can be detected. Nevertheless the presence of carbon dioxide in the atmosphere of Venus, and of methane and ammonia in the major planets, has been conclusively established. But this knowledge deals only with the outermost envelopes of the planets. What can we say regarding the main masses?

Here we must combine old astronomical data with new information from the physical laboratories. It has been known for more than a century that the mean density of the Earth is about twice as great as that of the surface rocks, and that Venus, Mars, Mercury and the Moon, though somewhat less dense, were all denser than common rock—while Jupiter was but little denser and Saturn on the average less dense than water. Later observations showed that Uranus and Neptune, in this respect, closely resembled Jupiter.

This did not exhaust the information which could be obtained by "classical"—that is, gravitational—methods. A rotating planet is bulged at the equator by the centrifugal force. For bodies of the same density and rate of rotation, the ellipticity would be the same, provided they were homogeneous; but if the central core is denser than the surface, the ellipticity will be smaller. In this way it can be shown that Mars is nearly of the same density throughout and the Earth considerably denser at the center, while for Jupiter and Saturn the central condensation is very great.

This evidence, combined with more recent seismological data, has led to a satisfactory picture of the Earth as a solid mass of rock, of types somewhat denser than the surface slag of granite, with a core of iron, probably still molten. Venus is presumably very similar, while the iron core must be much smaller in Mars, and absent in the Moon, and probably in Mercury.

THE greater planets may well have cores of rock and iron, but most of their bulk must be composed of matter of much lower specific gravity. Nearly 40 years ago Moulton suggested that they contained great quantities of hydrogen, as does the Sun, while the smaller planets had lost most of their hydrogen by diffusion into space.

The more recent discovery of hydrogen compounds in the atmospheres of the major planets fully confirms this view. It now seems quite clear that, if a mass of this order of magnitude and of composition similar to the Sun were permitted to cool from incandescence, the refractory constituents would settle out to form a dense core of metal and silicate rock. The outer gaseous portions containing oxygen, nitrogen, carbon, and so on, with an excess of hydrogen, would not condense till much later. The first compound to settle out would be water, forming an enormous ocean, which later would freeze into a thick layer of ice. Above this would be an atmosphere of hydrogen and perhaps helium and neon, containing such hydrogen compounds as ammonia and methane. At still lower temperatures the ammonia would freeze out. Uranus and Neptune appear to be in this stage, and Jupiter and Saturn in the preceding one. The finale, with only a transparent hydrogen atmosphere left, is not found in our system.

This would be a quite satisfactory representation if the cooling mass had been under low pressure: but it must not be forgotten that the force of gravity at the planetary surfaces is considerable, and the outer layers thousands of miles thick. A simple calculation shows that, even a few hundred miles below the surface, the pressure must already be so great as to reduce ordinary gases to about the density they have when liquefied, while, throughout most of the interior, the pressure far exceeds any which can be

Photographs courtesy Westinghouse Electric and Manufacturing Co.

The three segments of the horseshoe bearing at the north (upper) end of the yoke which will carry the tube of the 200-inch telescope. When bolted together these segments will take the form of a horseshoe weighing 317,000 pounds

GREAT PLANETS

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

studied in the experimental laboratory.

From the known data regarding the size, mass, and central condensation (or moment of inertia) of a planet, it is possible to work out a "model" compound of three layers of material of given density. This was first done by Jeffreys, assuming a core of rock, an intermediate layer of ice, and an outer atmosphere of compressed hydrogen. Wildt—one of our best authorities on planetary matters—has recently published a detailed discussion from which much of what here follows is taken. Repeating his calculations, with allowance for the increase in density by compression so that the rock is six times as dense as water, the ice 1½ times as dense, and the compressed gas ¼ as dense, he finds for Jupiter a dense core of diameter 43 percent that of the planet—37,000 miles—surrounded by a layer of ice about 13,000 miles thick, and then 12,000 miles of gas. For Saturn this core is 18,000 miles in diameter and the outer layers 15,000 and 12,000 miles thick.

THIS is too generalized a model to be exact, but it suffices to show that the internal pressures must be very high. At the bottom of the outer layer this comes out 940,000 atmospheres for Jupiter and 660,000 for Saturn: at the outer surface of the core 12,000,000 and 3,800,000 atmospheres, respectively, and at the center 59,000,000 and 16,000,000. In the upper tenth of the outer layer the pressures reach the highest value which has yet been studied accurately in the laboratory (about 50,000 atmospheres[1]). Below this, we have to rely upon extrapolation.

This is none too certain, especially for the ice layer, for ice is one of the substances which exists in several polymorphic forms, Bridgman having recently discovered a seventh, stable at pressures from 20,000 to 40,000 atmospheres. Whether still more changes occur at higher pressures, we do not know. We do know, however, that the distinction between liquid water and vapor exists only below the critical temperature of 374 degrees, Centigrade (or 647 degrees on the absolute scale). Above this temperature there is a continuous change of properties with increasing pressure and density without any separation of liquid.

It is generally believed among physicists that there is no similar effect for the solid star. At any pressure there will be a definite melting point. From the existing data, Wildt estimates that the melting temperature of ice VII would be 374 degrees at a pressure of about 100,000 atmospheres. This is a rough value—an extension of the curve for ice VI from 300,000 atmospheres. But the pressure at the top of the ice layer, even in Saturn, is more than twice the higher figure. Wildt concludes that as these great planets cooled the water probably froze to a solid before it could condense to a liquid, passing directly from the superheated fluid to the solid states. The margin at the top of the layer is not large and he adds: "The transitory existence of a shallow sea cannot entirely be ruled out." In the deeper part of the ice layer, at a pressure of several million atmospheres, freezing may have occurred while the temperature was almost what we usually call "red hot."

What the temperature in this ice-layer is at present can hardly be estimated; it depends, among other things, upon the amounts of radio-active material in the core. But it seems clear that the ice must be in one of the high-pressure polymorphic forms, and much denser than ordinary water.

For hydrogen the critical temperature is so low that it can be reached, and the gas liquefied, only by special laboratory technique. But, at a pressure of half a million atmospheres, even this "permanent" gas may be solidified.

The idea that, above the shell of dense ice, there may be a thick layer of solid hydrogen—not cold, but hot, in the ordinary significance of these terms—sounds like the wildest of dreams. But the possibility is based upon the extension of a tested physical formula beyond the realm of observation. Molecular physics is not yet in a position to calculate from pure theory what the melting point should be, and the formula has therefore a certain empirical element, especially in the numerical values. But it is physically reasonable, while the older estimates, disregarding high-pressure effects, were not.

SUCH theory as exists at present suggests a still more picturesque possibility. All students of chemistry recall that hydrogen comes in the same column of the periodic table as the alkali metals—lithium, sodium, and so on, and the question, "Why is hydrogen not a metal?," is an old one. We may say now: "Because its atoms tend to pair off into molecules instead of forming a crystal-lattice with freely moving electrons, as do those of lithium," and recall that a similar tendency to form diatomic molecules makes nitrogen an almost inert gas of very different properties from its homologue phosphorus. Certain theoretical calculations of Wigner and Huntington indicate that at pressures of a few hundred thousand atmospheres, hydrogen might pass over into a crystal-lattice, that is, into a metallic state. It would then be more than half as dense as water, and conduct electricity freely. Whether this can actually happen, 10,000 miles beneath the surface of Jupiter, no one can yet say. But the possibility is good evidence that the advance of physical theory has not taken the picturesqueness out of astronomy—any more than steam has spoiled romance at sea. The more we know, the more remarkable, as well as the further-reaching, are likely to be our conclusions.—*Mount Wilson Observatory.*

Loading the south (lower) cross-member for the yoke of the 200-inch telescope on a freighter near Philadelphia for shipment to California. This big member is 46 feet in length, 10 feet in width, 12 feet in height, and weighs 90,000 pounds

[1]In the article by Bridgman, Scientific American, August 1935, p. 80.

GRAND COULEE PROGRESSES

Monster Dam and Appurtenant Works Will Cost Over 376 Millions . . . Dimensions . . . Components . . . Progress of Work . . . Difficult Problems Met

By R. G. SKERRETT

GRAND COULEE DAM, in the state of Washington, is being steadily reared from the depths of the Columbia River Canyon toward its ultimate maximum height of 553 feet. Work on this tremendous undertaking has been divided into two major contracts: one embracing the building of the so-called "low dam," rising well above the high-water level of the river; the other calling for the completion of the integral but surmounting section, which will carry the dam upward to its prescribed final crest line. The low dam section was finished in January, 1938, and work on the remainder of the gigantic concrete barrier was started during the first half of the current year.

The low dam was authorized in 1934 because it would give relief to the unemployed and the structure, when finished, would make it possible to generate a large block of marketable electricity when plant for that purpose should be installed. The building of the high dam, now underway, will serve much broader fields, because it will make possible generation of a considerably greater amount of power and render practicable irrigation of 1,200,000 acres of rich but now virtually arid lands in the Columbia Basin. Indeed, the fundamental purpose of the Columbia Basin Project, of which the Grand Coulee Dam is the key feature, is the agricultural development of this particular region. Any surplus electricity may be distributed to consumers located within a radius of 300 miles from the dam site. The lands to be benefited by water pumped from the river will provide home sites for some 150,000 persons and will, in addition, support on the project an urban population of 150,000 people. The fruits of the soil will, of course, be distributed throughout a far wider territory and contribute to the sustenance and well-being of a great many more thousands of our citizens.

WHEN the Columbia Basin Project was described in these pages, early in 1935, some emphasis was laid on the geological happenings that brought about the erosion of the deep, broad, and long Grand Coulee which, for 25.2 miles, is to be used as a balancing basin to store, for a prompt draw-down, 329,000 acre-feet of water that can be fed by gravity flow whenever needed for irrigation. But nothing was told in our earlier article about what the same stupendous forces did 25,000 years ago in the canyon of the Columbia, where the Grand Coulee Dam is building. The invading ice sheet, which blocked the canyon below the dam site, raised the level of the river about 1500 feet, and detoured the stream westward where it eroded the Grand Coulee and, incidentally, overlaid the bed of the Columbia with a deposit of glacial drift, or till, that attained a vertical thickness of 500 feet. What happened afterwards, when the river worked ceaselessly to readjust itself and to burrow downward toward its ancient level, brought about conditions in the canyon that have presented major problems to the dam builders.

When the Cordilleran ice sheet retreated, and the Columbia was free to resume its ancient course, the river proceeded to dig into its new bed of glacial material and to scour restlessly an ever-changing channel until it worked its way to the course traced by it in modern times. At the dam site, in midstream, the bed of the river is now from 40 to 50 feet thick over the underlying and far-reaching basic granite. From the center of the stream, outward and upward throughout the length of the dam, the overburden, of glacial origin, increases in depth to a maximum of 200 feet, but beyond that range the depth is greater. The canyon slopes are blanketed to a height of 500 feet with material that formed part of the river bed laid there by the Cordilleran ice sheet. As the river worked its way downward, its banks were successively undermined and the disturbed silt and drift slid and readjusted themselves before coming to rest. Some areas finally attained a measurable degree of stability, while others, even today, are insecure. It was because of this condition, a heritage of many centuries, that slides have occurred repeatedly during the excavation of the dam site. In the earlier stages of the work,

The extraordinary belt conveyor system which transported excavated material from both sides of the river to Rattlesnake Canyon, hundreds of feet higher, where it was then dumped

while excavating where the west abutment of the dam was to rise, a single slide of 2,000,000 cubic yards moved down and athwart the roads built by the contractor to give him access to his operating area. That slide cost time and money to stabilize and to reconstruct the damaged roadways, and, with some lesser slides, influenced the Government in its decision to abandon the idea of a low dam, as such, and to go forward, instead, with the erection of the high dam now in hand.

The low dam was designed to serve, in part, as the foundation for a future high dam, and the latter structure would have required additional and somewhat extensive excavation to afford the necessarily broader base contact with the foundation bed rock. The engineers of the U. S. Bureau of Reclamation realized that later operations might invite renewed and possibly very costly, if not menacing, slides. Therefore, it was the part of wisdom to build a high dam at an early date. Furthermore, there were involved some uncertainties concerning the effectiveness of the bond that could be made between the supporting surfaces of a completed low dam and the superposed concrete mass that would form the body of the high dam. It was feared that the vibrations that might be set up at flood stages, with the pool at its maximum elevation, would weaken and perhaps overtax the bond between the old and the new concrete. Accordingly, a change order was issued by the Federal authorities in June, 1935, and construction of the much desired high dam—urged consistently by the Columbia Basin Commission of the State of Washington—was started. The preparatory work up to that time made that course feasible.

Pouring concrete within the towering east cofferdam for the central section of dam. Each bottom-dump bucket such as the one shown holds four cubic yards, or eight tons, of concrete

THE contract for the original low dam, made with the Mason-Walsh-Atkinson-Kier Company in 1934, called for a structure that would contain 3,600,000 cubic yards of concrete. For the agreed sum of $29,339,301, the contractor stood ready to build the substructure to a height of 177 feet above bed rock and rising well above flood-water level—that substructure ultimately to be surmounted by a contemplated much higher dam. The low dam section was finished in January, 1938, and contained the required 3,600,000 cubic yards of concrete; but the high dam, with its appurtenant structures, will bring the total amount of concrete placed up to 10,250,000 cubic yards—a volume of concrete 2⅓ times greater than the amount used in building Boulder Dam and its various associate features.

From its lowest contact with bed rock to the top of its crest, Grand Coulee Dam will rise 553 feet. From wall to wall of the canyon, the structure will have a maximum length of 4200 feet. Where it rests on the sustaining granite, the dam's base has a transverse spread of 500 feet. Along its crest, which is 30 feet in width, there is to be a roadway 26 feet wide connecting with a highway on each flank of the canyon. The spillway, centrally located, will be 1650 feet long and 47.6 feet lower than the crest of the dam. That spillway is to be equipped with 11 steel drum gates, each 135 feet in length; when those gates stand up to their full height of 28 feet, the level of the impounded water will be 357 feet above the Columbia River at low stage. The basin, when filled to capacity, will hold 10,000,000 acre-feet of water, and the back-water will extend upstream to the Canadian border, 151 miles distant. When the spillway gates are lowered into their recesses in the crest of the spillway, the 11 openings will permit the escape of water at the rate of 1,000,000 cubic feet per second—a volume more than twice as great as the recorded maximum flood discharge of the river at the dam site. The pool above the dam will provide a storage of 5,200,000 acre-feet of water which can be withdrawn, as needed, for irrigating the lands of the Columbia Basin Project.

The body of the spillway section of the dam, below the crest of the spillway, will be pierced at three different levels, 100 feet apart vertically, by a total of 60 gated outlets 8½ feet in diameter, through which water can be released into the river below the dam to maintain a regulated flow for purposes of power development and navigation on the river below the Grand Coulee Dam. On each side of the river, at the downstream face of the dam, there is to be a power house in which will be installed nine prime turbines, each of 150,000 horsepower. In the west power plant there will also be three smaller service units. All told, the ultimate generating capacity of the two power plants will total 2,182,500 kva. The generating capacity of the Grand Coulee Dam will be about 50 percent greater than that of Boulder Dam.

The average annual flow of the Columbia, at the dam site, is 109,000 cubic feet of water per second, while the corresponding flow of the Colorado River is

not much more than one fifth of this. Grand Coulee Dam will be the means of increasing by 100 percent commercial power development between the new structure and the point where the Snake River joins the Columbia, and will add 50 percent to the potential power development below that point.

On the upstream side of Grand Coulee Dam, at the western abutment, there is to be constructed a pumping plant in which will be placed 12 big electrically driven units having a combined discharge of 19,200 cubic feet a second. Each pump will force the water up hill to the western crest of the canyon through a pipe 10 feet in diameter; depending upon the level of the pool, the pumps will raise the water from 295 to 367 feet, in order to deliver into a canal 1.7 miles long leading to the northern end of the Grand Coulee reservoir. Grand Coulee Dam, when finished, and equipped with all its turbines and generators, will cost \$178,790,000. The pumping plant and the supplemental features of the irrigation system of the Columbia Basin Project will entail an added outlay of \$197,841,000. Thus the total will be \$376,631,000, according to the estimates of the U. S. Bureau of Reclamation, which has designed the dam and the other features of the comprehensive project, and is directing the present work.

The first great problem confronting the contractor was how to dispose of approximately 15,000,000 cubic yards of earth and rock that would have to be excavated in clearing the dam site in advance of starting actual construction, after the Government had made the location accessible by building a branch railroad 32 miles in length. The canyon, adjacent to the dam site, offered no low ground for a dump within several miles along the river, and to build roads and to use motor trucks to haul the soil away would have imposed prohibitive costs. Therefore, the contractor developed a flexible and efficient belt-conveyor system that could carry the muck from the first scene of operations, on the west flank of the river, accommodate itself to the steep and changing contours of the canyon for an ultimate distance of 1½ miles, and climb approximately 500 feet to dump into an immense pocket known as Rattlesnake Canyon. That belt conveyor has moved in the course of a working day nearly 51,000 cubic yards of spoil. The feeder belts, that delivered to the main belt, radiated to the active points of excavating so that the motor trucks and tractor trailers had to move only a short distance in carrying their loads from the power shovels to the feeder units. This belt-conveyor system first served the excavation within the west cofferdam and then transported selected material for ballasting the cells forming the walls of the west cofferdam. Later, with a suitable extension, the system moved spoil from the east cofferdam and carried the waste material across the river and thence up to the main dump in Rattlesnake Canyon. The installation operated night and day, in fair and foul weather, saved months of time and a large amount of money. It was an adaptation of a system used in 1932, during the driving of the Boston vehicular tunnel under a section of that city's harbor.

Excavating the site for the western abutment of the dam was done within a cellular type cofferdam 3000 feet in length, for the most part parallel with the river, but with the ends of the structure turned more or less inshore. All told, 13,000 tons of steel sheet piling were used in constructing the cofferdam, and the piles ranged in length from 35 feet to 80 feet. The piles for a cell were assembled on the surface of the ground, like a towering fence, and then driven, against increasing resistance, with the aid of four steam hammers equipped so that each could drive two piles at a time—the hammers being suspended from a gantry that made it feasible to shift them easily so that piles could be driven successively around the rim of the cell. The novel arrangement of the gantry enabled the contractor to do his work with speed and to complete the structure in three months during a winter when the thermometer dropped to 20 degrees below zero. Haste was essential in order that advantage could be taken of the low stage of the river and so have the cofferdam ready for service in advance of the succeeding months of high water. At flood stages, the river rises from 40 to 62 feet above the winter or low-water level.

THE east cofferdam, within which most of the spillway section of the dam and the east abutment have been constructed, utilized much of the main river section of the erstwhile west cofferdam—an area over which the diverted river flowed while the east cofferdam was in use.

A leak developed when excavation of the eastern area was well below the river level and in the vicinity of one of the two major cell groups that had first served for the west cofferdam. Some of the deeply driven piles had penetrated a layer of coarse sand; water, under sufficient head, followed upward around the piles when the work required the removal of an embankment that had been placed about those cells. The invading water increased in volume until it was flowing 35,000 gallons a minute. Before that stage was reached, a dike was built around that corner of the cofferdam to confine the inundation, and then the next problem was to seal the leak. Despite feverish efforts to arrest the inflow by dumping earth, riprap, and other obstructing materials on the riverside bases of the cells, large volumes of water still came in. Then the engineers determined to do the unusual—tried to shut out the water by blocking it from the inside of the cofferdam. The first thing was to locate the channels in the sand stratum through which the river was making its way. That was ascertained by numerous exploratory drill holes. Next, a filtering layer of broken rock was dumped on the leaking area. Then, upon that rock was laid a thick blanket of gravel heavy enough to resist displacement by the pressure of the outlying and higher river. The stage was then set for sealing the filter bed by dumping into the sand seam and the broken rock, under pressure, a

onstructing forms and placing reinforcing steel bars of the great 18-foot penstocks that will
liver water to each of the 150,000 horsepower turbines, of which there will be a total of 18

grout composed principally of cement, sawdust, shavings, and Bentonite. Bentonite is an earth that, when saturated. expands from 10 to 30 times its original volume and becomes a gelatinous mass. The Bentonite, combined with the other ingredients of the grout, plugged successively the gravel and the rock of the filter bed and then sealed the sand stratum through which the water had previously worked its way into the cofferdam. To do the trick, more than 12,500 sacks of cement, 125,000 pounds of Bentonite in lumps and pulverized, 4600 cubic feet of sawdust, and more than 6800 cubic feet of shavings were used. In three days, an inflow of 8000 gallons per minute was cut down to less than 1000 gallons per minute; and it took only a short time more to reduce the leakage to as little as 200 gallons a minute, which was easily kept under control.

Midlength of the eastern cofferdam, and athwart the axis of the dam, there was exposed a narrow ravine that dropped abruptly to a depth of 120 feet below the general surface of the bared bed rock. That ravine had to be excavated, but before it could be cleared, a slide started toward it from a flanking area. The contractor reared in the bottom of the ravine a concrete arched dam and mounted upon it a rock-filled timber crib which was to be backed on the pressure side with heavy riprap. The slide immediately afterwards resumed its advance, buried the man-made obstruction, and poured into the ravine too fast for a good-sized power shovel to overcome it. The slide was halted effectually only by freezing about 3000 cubic yards of wet and fluid earth and creating a dam from side to side of the ravine. The freezing was accomplished by pumping brine from two ammonia compressors, the total capacity of which was 80 tons of ice per day, through 377 freezing points—pipes driven into the damp earth.

All photographs courtesy U. S. Bureau of Reclamation

Steel trestle 3000 feet wide and 175 feet high paralleling axis of the dam and used for trains and cranes handling concrete and steel. It will be embedded in the concrete of the completed dam

IN handling bulk cement, the contractor profited by what had been done earlier at Boulder Dam. The cement reached the western slope of the canyon by a branch railroad and was there stored in capacious silos. From the silos, the cement was blown by compressed air through two 11-inch pipe lines. One of these, 2000 feet in length, delivered the dry cement to the west-side concrete mixing plant, and the other pipe line carried similar cement to the east-side mixing plant, 6000 feet distant. Each mixing plant, several stories high, and itself elevated, fed the concrete and the aggregates by gravity to the batchers and mixers, and the concrete thus prepared was dropped into bottom-dump buckets, set on flat cars which hauled the concrete to the points of placing. Each dump bucket was of four-cubic yard capacity—that is, eight tons; and the batching, mixing, and discharging were virtually under automatic control subject to the master direction of a centrally located dispatcher who, in turn, was linked by telephone with foremen at the different pouring points throughout the various parts of the widespread scene of operations. The highly mechanized facilities made it possible to pour in a single month more than 400,000 cubic yards of concrete. No wonder the work of building the low section was completed some months sooner than called for under the contract.

The body of Grand Coulee Dam, from bed rock upward, is composed of a series of great interlocking blocks of concrete, with intervening contraction joints that have been successively filled with grout to unify the structure. The blocks in the spillway part of the dam are 50 feet square in plan, but elsewhere the blocks are of lesser unit dimensions to meet differing structural requirements. The blocks have been uniformly poured in lifts of not more than five feet in height during a given 72-hour period; and on top of each completed lift or block has been laid parallel lines of 1-inch pipe in advance of pouring the concrete for the superposed block. These pipes, which have been filled with grout after serving their purpose, carried river water that was pumped through them to absorb the heat induced by chemical action while the concrete was setting. That cooling offset the expansion of the concrete and prevented the development of disruptive forces that have often cracked and seriously damaged large masses of concrete that were not so cooled.

In January of the present year, an aggregation of experienced contractors was awarded the job of completing the surmounting body of the high dam. That work is now going forward in the hands of the Interior Construction Company at an award cost of $34,443,240. The contract calls for placing 5,250,000 cubic yards of concrete, containing 160,000,000 pounds of reinforcing steel; installing 10,000,000 pounds of piping, 50,000,000 pounds of gates and operating apparatus, 24,000,000 pounds of trash-rack metal; and proper placing of penstocks having a combined weight of 16,000,000 pounds. The Government will provide the electrical plants in the two power houses; the generators will have a total capacity of 2,700,000 horsepower when all the units are in place. The Government will also equip the great pumping plant on the west side of the valley which will lift water from the river and start it on its journey toward the lands of the Columbia Basin Project. The distributing canals will reach to all parts of an area about 100 miles in length and 60 miles in width; in dropping from the initial reservoir to the lowest level of the farmlands, there will be sufficient head to generate power to operate pumps and so raise a part of the water a maximum of 100 feet to irrigate about 200,000 acres that could not otherwise be brought under cultivation.

The Columbia Basin project is, indeed, an engineering undertaking of splendid proportions and of major importance. When brought to its designed consummation, the enterprise will no doubt amply justify outlays that will total, according to present estimates, $377,000,000—$179,000,000 for the dam and power plant and $198,000,000 for the irrigation system. Work on the Grand Coulee project is under the direction of Mr. John C. Page, commissioner, U. S. Bureau of Reclamation.

Tools Must Be Fit

Hard Alloy . . . Cobalt, Chromium, Tungsten . . . Welded to Wearing Edges . . . Resists Wear . . . Withstands Heat . . . In Tools, Cuts Faster, Lasts Longer

By E. E. LeVAN

SEMI-PRECIOUS metals used in farm implements? Although seemingly unreasonable from either a useful or an economical viewpoint, it is actually being done. And because a special alloy of these metals is used, the farmer's cost of plowing, cultivating, and harvesting is substantially lower. The paradox is easily explainable.

As might be anticipated, only a relatively small amount of special alloy is used, and it is used only where it does the most good. Actually, it is a very wear-resistant, stainless alloy of cobalt, chromium, and tungsten, and it is welded only to those edges or surfaces of implements which receive the brunt of the wear. Thus, a few ounces of the alloy protect an expensive implement, and the protection afforded makes the whole part last much longer.

Farm implements are only one application of this principle, for industry as a whole makes wide use of this alloy to protect wearing parts.

Steel mills use it on enormous shears which clip off steel billets as easily as a tailor cuts cloth. Automobile manufacturers protect countless metal-working dies with it. Power plants, developing steam pressures of 1000 pounds per square inch and higher, use valves having seating surfaces "hard-faced" with this alloy. And, now, most large bus and truck engines are equipped with exhaust-valve seat inserts protected by a layer of the same wear- and corrosion-resistant materials.

This alloy is no new discovery. Its history dates back to the period before the World War, when Elwood Haynes was manufacturing "horseless carriages." Haynes, a mechanical genius, was also an eminent metallurgist. He was always interested in chromium alloys and had done considerable work on stainless steel. At this time, however, he was searching for a stainless material from which to make tableware and cutlery. Several alloys of cobalt and chromium, which he made, were non-tarnishing, silvery and, on the whole, very suitable. On further experimentation, however, he added tungsten to his mix and the resulting material on solidifying was so hard that no ordinary tool steel would cut it. Observing this, Haynes decided that the metal might be adaptable as a cutting-tool material in his automobile plant. It worked splendidly.

Development followed rapidly. During the War, when production of machine parts was at its peak, Haynes Stellite, as the alloy was named, was an invaluable aid. Cutting at higher speeds, it increased production far above the level obtainable with ordinary steels. Because of this fact too, Haynes Stellite cutting tools began to be employed in machining operations throughout the manufacturing world.

SOON after the War, the process of applying this hard alloy as an abrasion-resistant coating on other metals was perfected and generally adopted by industry. In 1924, this process was first introduced for protecting the drilling and reaming edges of oil-well drilling tools. Although drilling bits are subject to terrific abrasive action, the Stellited edges proved their economy by preserving the bits to several times their former life. Although oil-well bits are now hard-set and hard-faced with an even more wear-resistant cast tungsten carbide diamond substitute, the silvery, hard, cobalt-base alloy is the standard hard-facing material wherever both surface smoothness and abrasion resistance are required.

The years from 1920 on have seen an enormous increase in the number of applications for which this alloy is used. Typical examples of hard-faced parts are: plowshares; metal stamping dies; hot-metal shears; automotive, aircraft, and steam valves; excavating bucket teeth; glass shear blades; road graders; brick molds; pump shafts and pulverizer hammers. The list now includes equipment used in every industry.

High-speed cutting of steel is easy for cobalt-chromium-tungsten alloys

Specific examples of hard-facing will illustrate how this alloy has been used to overcome specific problems of wear under extreme conditions.

Steel jaws for holding two pieces of metal to be welded in an electric flash-welding machine are subjected to severe operating conditions. Suddenly they are clamped, vise-like, into the work. A heavy current is applied through them, as contactors, to the steel parts to be welded. The full discharge of the welding current through the jaws produces a considerable amount of heat. As the weld progresses, flying sparks of hot metal strike the jaws, and, while the jaw surfaces are still hot, the finished work is quickly released. Naturally, steel jaws cannot last long under such service conditions. A company manufacturing ½-inch steel pipe couplings, recently found that if the jaws were hard-faced by oxy-acetylene welding a layer of the cobalt alloy to the jaw-gripping faces, they lasted 10 times as long as new steel jaws.

Hard-faced valve at right after 650 hours; center, steel after 150 hours

This principle has also been carried out on a larger scale at one of the large middle-western steel plants. Here, the bits of grappling tongs for raising hot steel ingots from the blooming mill soaking pits were surfaced with this alloy. The application has been very economical. Where, formerly, 19,000 bits were kept on hand continually, a large reduction in inventory is now possible since tong bits with hard-faced points last over six times longer than new steel bits.

In hydro-electric plants using very high heads of water as a source of power,

The dough scraper, hard-faced, in long service without reconditioning

the directing nozzles and valve needles have to be extremely accurate so that peak efficiency of the turbines can be maintained. At one installation in California, the water, under a head of 2200 feet, travels at a rate of over 400 miles per hour through the nozzle. It is only natural that even hardened steel nozzle throats and needles should be severely eroded in a short time. Hard-facing increased the life of these parts from three months to over six years.

IN making bread, the dough is kneaded in a molding machine. By passing the dough through a series of rollers and then over curling rolls, the texture is improved and all the air bubbles are pressed out. Naturally the machines must be kept as clean as possible and the dough must run through evenly. To prevent it from sticking to the rolls, it is scraped off by blades held by springs against the rolls. Originally, molding machine manufacturers employed hard steel scrapers. These presented a problem, however, because of their tendency to cut and sometimes scratch the rollers. Softer scrapers were then tried, but wore out rapidly.

Recently, however, a New York City bakery solved this problem by hard-facing the wearing edges of the scrapers by oxy-acetylene welding. Because of

A cobalt alloy roller is used in this machine to burnish freight car axles

its low coefficient of friction and the high polish taken by the hard-facing alloy, it does not scratch the roller. In addition, since the alloy surface is perfectly stainless, the scrapers are easy to keep clean. But the principal advantage gained is that the former difficulties with steel scrapers are now entirely eliminated. While steel scrapers had to be refinished every three months, hard-faced scrapers have now been in service for many more months without showing the least sign of wear.

Grinding the valves used to be a frequent expense on the old family car. The accompanying photograph of valves tells its own story. The steel valve head is burned completely through after only 150 hours of service, while the hard-faced valve is still in excellent condition after over 650 hours.

High-pressure, high-temperature steam valves serve in much the same manner, and, for this reason, it is only natural that they, too, should likewise be protected. Numerous installations have proved the value of hard-facing steam valves, and have shown clearly that, when the seating surfaces of valves for high-pressure, high-temperature steam service are hard-faced, they last from six to ten times as long as ordinary steel valves.

Protective coatings applied by hard-facing do not represent the only use for cobalt-chromium-tungsten alloys. Their principal use is that which Elwood Haynes foresaw 30 years ago—metal cutting tools. "J-Metal" and "2400," the grades used for cutting tools, are daily performing machining miracles in automotive plants. They are used for turning, facing, boring, and milling nearly all grades of cast iron, malleable iron, and steel, as well as for performing certain operations on specialized high-production jobs.

Railroad shops are also reducing machining time and costs with cutting tools of this material. Pistons and piston rings, valve bushings, and air-pump cylinder bushings are only a few representative parts now being machined with cobalt-chromium-tungsten alloy cutting tools.

After car and locomotive axles are rough-turned on a lathe, they are rolled or burnished to smooth out the bearing surfaces. This is done on a lathe where the axles revolve while a burnishing roller, pressed tight against the bearing surface, rolls out imperfections and produces a mirror-like surface. Because of the hardness and extreme smoothness required in a roller for such exacting work, rollers of this same cobalt-chromium-tungsten alloy are employed by leading railroad shops. In one shop, where special steel rollers develop irregularities after burnishing less than 2000 axles, rollers of this cobalt alloy have burnished over 21,000 axles in five years of maintenance-free service.

THE economy of hard-facing is well illustrated in the case of farm plowshares, which have been studied by several state university agricultural experiment stations. The results of these surveys indicate that hard-faced shares ultimately cost the farmer only one-third to one-half as much to use as plain steel shares. These figures are averages of results obtained in different states throughout the country. Including intangibles, the savings made by using hard-faced plowshares are even greater, because there are only one-fifth as many stops to change shares and fewer trips to town for resharpening service—a substantial time saving. In addition, the hard-faced shares are found to "scour" and stay in the ground well, plowing to a more uniform depth.

Similar results are being obtained in machine shops using tools of this alloy. The initial cost of tools is slightly more, but production is increased—in many cases, up to 150 percent—because of the increases in speeds and feeds made possible by the unique qualities of the alloy. In addition, the number of pieces turned out between tool sharpenings is substantially increased—insuring more continuous production as well as lowered ultimate tool costs.

The adaptation of the alloy to such a variety of uses affects almost every commodity we buy. Consider the family car again. From bumper to bumper it has been shaped by dies and tools hard-faced with or made of solid cobalt-chromium-tungsten alloy. Many parts of the engine and transmission have been machined with tools of this alloy. Many of the body stampings have been made of the same alloy, which is also used in the knives to cut the upholstery cloth and tire fabric. The oil and gas on which the car operates have been produced from wells drilled with hard-faced tools and handled in the refinery by means of Stellited pumps and valves. And finally, even the cement in the concrete road upon which the car runs has been ground in mills of this wear-resistant alloy.

MAKING NEW ATOMS

Many New Forms of Matter are Being Produced by Modern Research in Nuclear Physics, but Science Knows no Way to Transmute Matter Economically

WITH the pioneer experiments in artificial transmutation of the elements less than seven years old, research in this field of nuclear physics is now being vigorously pursued in many physical laboratories. In consequence, hardly a month goes by without the announcement of the discovery of some new kind of atom in some laboratory. It appears that probably before long every kind of chemical element will be prepared in an artificially radio-active form, as in the case of those to be described, and that we are just at the beginning of a long and fruitful period of research into the applications of this host of new substances.

Let us recall the general ideas involved in producing new kinds of matter by transforming the nucleus. Each atom consists of a central nucleus which carries a charge of positive electricity surrounded by enough outer electrons (negatively charged) to make the whole atom neutral. The central nucleus also carries most of the mass of the atom, for the electron weighs only 1/1800 as much as the lightest nucleus, that of ordinary hydrogen.

In order to transmute an atom from one kind into another it is necessary somehow to affect the central nucleus, and this is not easy to do; first, because it is very small and so it is hard to hit and, second, because it is very tightly bound together and so it must be hit hard in order to break it up. A glance at Figure 1 will remind us of the scale of distances involved. Opposite the arrow at the top, is indicated a space which actually is exactly one centimeter in length—about four tenths of an inch. Going down the scale, each division corresponds to taking a length one tenth of the preceding amount, so the bottom of the ladder, which is 13 steps down, corresponds to a length of 1/10,000,000,000,000 centimeter. Opposite various places on the ladder are written the names of things whose size is appropriate to that place in this scale of lengths. Plainly, if the diameter of the nucleus is only 1/10,000 that of the atom, its cross-sectional area is only 1/100,000,000 that of the whole atom, so if we shoot a projectile into the atom at random (and we know of no way to take a better aim) there is only one chance in 100,000,000 of hitting the nucleus.

Hence a great many of the projectiles shot in will generally be wasted. Suppose, for example, we have accelerated a hydrogen atom nucleus or proton by letting it fall through a potential drop of 1,000,000 volts, and that it then strikes a target of matter which we wish to transmute. A competition begins. The proton, being charged, attracts the electrons of the atoms in the target, setting them in motion and thus losing some of its energy. By rare good luck it may hit a nucleus in the first layer of atoms in the target. But, if it does not, it goes on to the second layer; however, with diminished energy because of what it has lost to set the electrons in motion. In the second layer it again has a very small chance of hitting a nucleus and it continues losing energy to the electrons. In general, if it does not hit a nucleus it will penetrate about 100 atomic layers before being slowed down so much that it would be unable to make an effective hit. In each layer its chance of success is one in 100,000,000, so in all 100 layers it is about one in 1,000,000.

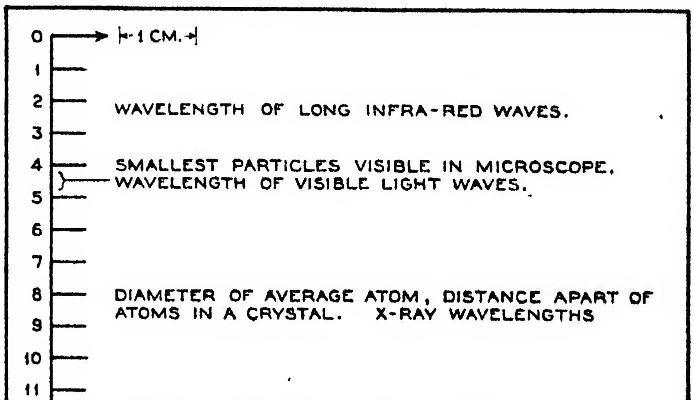


Figure 1: **Each vertical step downward corresponds to a length one tenth that of the previous step, starting with one centimeter (shown full scale at top) and extending down 12 steps to the atomic nucleus—the smallest thing known to science**

This, in a nutshell, is the reason why it has not been possible to make the new transmuted elements on a large scale: *We do not know how to aim the projectiles in order to increase the percentage of hits.* Thus a great deal of the energy supplied to the suppositious transmutation machine goes into accelerating projectiles which never do anything effective. That is why physicists generally feel that this kind of research is not going to give any new source of power in a form useful for heavy industry, even though immense stores of it are latent in the atomic nucleus. But that does not mean that the new nuclear physics is without value, for the new materials that are being produced are already finding wide application in biological and medical research.

BUT let us consider more in detail what happens in those rare events in which a successful hit is made, to see why it is that physicists everywhere are devoting their whole attention to these studies. To appreciate the situation, we must remember that the central nucleus is believed to be built of two kinds of particles, the proton and the neutron. The proton has unit atomic weight on the chemist's scale (approximately) and is positively charged with what we shall call unit charge, the same degree of charge as the negative charge of the electron. The neutron has essentially the same weight as the proton but carries no charge. So a nucleus gets its total charge from the protons contained in it and its mass comes from the joint contribution of the protons and the neutrons.

We may make a graph in which there is a place for every conceivable kind of nucleus by plotting the number of neutrons on a vertical scale and the number of protons on a horizontal scale. This has been done in Figure 2 for the chemical elements of low atomic weight.

In this diagram the kinds of atoms which are known to exist stably in nature

IN THE LABORATORY

By E. U. CONDON, Ph.D.
Associate Director, Westinghouse Research Laboratories

are indicated by solid circles. It will be noticed that these occupy the central part of the diagram, corresponding to equal numbers of protons and neutrons or only slight departures from this rule. The part of the diagram corresponding to very heavy hydrogen, say of atomic weight ten—one proton and nine neutrons—is blank, and so is the part corresponding to nuclei containing many protons and few neutrons. There must be something about the forces holding nuclei together which favors the nuclei having equal numbers of neutrons and protons and makes the others unstable.

In the diagram will also be found two other sets of circles, some containing plus signs, the other containing minus signs. These represent the new kinds of atoms, all of which have been discovered in the last few years by research in nuclear physics. Why they were not found in nature is also clear, for they are all radio-active—that is, unstable—and disintegrate in periods from a few minutes to a few days; at any rate, so rapidly that none could survive geological epochs even though some supplies of them were initially present.

These radio-active atoms all disintegrate in one of two ways. Those marked with a *minus* sign shoot out electrons spontaneously and thus, in effect, gain a positive charge without appreciable loss of mass. It is the same as if one neutron changed into a proton by splitting off and ejecting a negatively charged electron. This results in forming as a product nucleus the kind that is downward and to the right one place each way, as indicated in Figure 3. Similarly, those in Figure 2 which are marked with a *plus* sign shoot out positrons or positive electrons spontaneously. This process is the same as if a proton in the nucleus changed into a neutron by splitting off and ejecting a positron.

It will be noticed in Figure 2 that all the electron-emitting elements are on the neutron-rich side of the stable elements and all the positron-emitting elements are on the proton-rich side. Not only are the elements which occur naturally the only stable ones, but the way in which the unstable ones break up is just that which results in a product of stable type. If the instability is due to an excess of neutrons the nucleus corrects this by shooting out an electron, while if it is due to an excess of protons the correction is made by shooting out a positron.

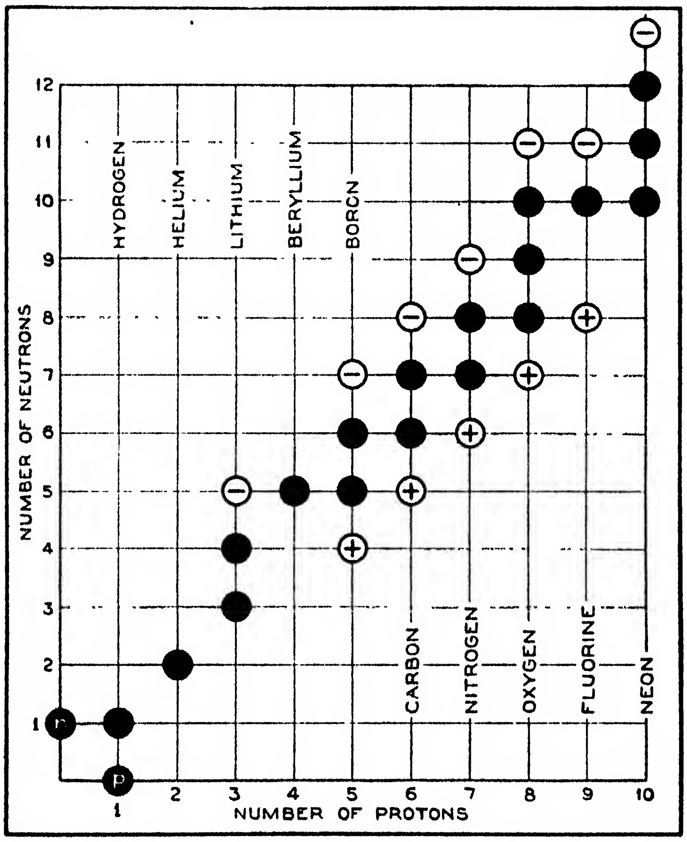


Figure 2: In the lower left-hand corner, marked *n* and *p*, are the simple units out of which the nuclei of all atoms are built. The shaded circles show the kind of nuclei occurring in nature for the ten lightest chemical elements. Circles with + and — signs inscribed within them correspond to the newly discovered radio-active species of the same elements which spontaneously emit positrons and electrons, respectively

So far we have not spoken very much about the nature of the projectile but that is important too. Nuclear transformations can be produced by hitting nuclei with:

a. Gamma rays or X rays of high frequency (short wavelength).
b. Protons obtained from high-voltage discharge tubes operated by a Van de Graaff machine or from a cyclotron.
c. Deuterons, or nuclei of heavy hydrogen, obtained in the same way as *b.*
d. Alpha particles, or nuclei of helium atoms, obtained from high-voltage discharge tubes or from the cyclotron.
e. Neutrons — which are themselves obtained from nuclear reactions in which targets are bombarded with one of the four preceding agents.

One might think that they could also be transformed by bombarding by high-voltage electrons, but this appears not to be the case. At least, there is no certain evidence for such processes, which means that electrons are much less effective than the agencies just listed.

GAMMA rays are least effective and the over-all process is especially inefficient, as strong sources of the gamma rays are not available. They have been shown to eject a neutron from the nucleus when they are absorbed by a process that has many points of similarity to the ejection of electrons from a metal by ordinary light in a photo-cell. The use of gamma rays is principally of theoretical interest in learning about nuclei and does not seem likely to be an important means of producing radio-active materials.

Neutrons are interesting projectiles with which to make nuclear changes. As they are uncharged they are not repelled electrically by the positively charged nucleus, so they do not have to hit it hard in order to penetrate. As a result, even a neutron that is going very slowly, comparatively speaking, is able quietly to fall into a nucleus and be captured by it. With the development of powerful sources of neutrons now in progress, this means of making active materials will probably be of greatest importance in the future. The ease with which neutrons are

captured, even when going slowly, is what accounts for their absence as free particles in nature. If a neutron is produced in any manner whatever, it will go through matter until it is caught by some nucleus within a very short time.

A great advance in our understanding of what happens in a nuclear collision has been made by Prof. Niels Bohr, of Copenhagen, the same man who, more than 20 years ago, pointed the way to understanding how the outer part of the atom is built. He points out that the various particles in a nucleus attract each other so strongly that, the instant the projectile enters, its energy is divided up among all the particles and capture is thereby effected because then no one particle has enough energy to escape from the attractions of the rest. This situation is in sharp contrast to what would happen, for instance, if a star were to enter the space occupied by the solar system. The solar system is such a wide-open structure that, although the star would undoubtedly set up great disturbances in the planetary orbits, it would be very unlikely to lose enough energy in this way to be captured and remain with the Sun to make a double start.

After the projectile is captured and its energy divided up among the other particles we are left with an intermediate or compound nucleus which contains all the particles that were originally in both the struck nucleus and the projectile. But it differs greatly from an ordinary nucleus, in that it has a great deal more energy than a stable one. This energy is in the form of energy of motion that is distributed among the various particles. After a time, more or less by chance (that is, by such a complicated sequence of events that we do not know how to calculate them), some one particle will get enough energy to escape from the attractions of the others and so will be expelled.

WHEN this happens, the product that results is in a more or less stable condition. If the material bombarded, the nature of the projectile, and the nature of the emitted particle, are such that the resulting atom is of the stable kind, then nothing further happens. A transmutation of the atom from one kind to another has been effected, but that is all. But if the atom is of an unstable kind then, after a comparatively long time—some hours or days—the nucleus will readjust itself by emitting an electron or positron, in an effort to change into a stable kind of atom.

So rapid has been the progress in this field that now literally hundreds of different cases are known in which different atoms are subjected to different transmutations by different kinds of projectiles. Right now a great deal of effort is being devoted to more exact study of the details of the processes—how they depend on the energy of the impacting projectile and details about the energy with which the emitted particles are sent out.

It will perhaps make the discussion clearer if we explain briefly the meaning of the symbolic equations which the nuclear physicist uses to describe atomic transmutations. It is now customary to denote one atom of a substance by the same symbol that the chemists use, prefixing it with a subscript that tells the

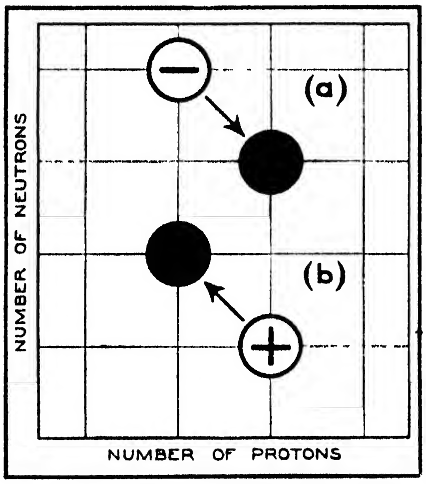


Figure 3: When an electron is emitted the change is as shown in (*a*), with one neutron changing into a proton. When a positron is emitted the opposite is true, as shown in (*b*)

number of protons in the nucleus and adding a superscript that gives the total number of neutrons and protons. Thus ${}_4Be^9$ stands for a nucleus of the kind of beryllium atom which has a total of nine protons and neutrons and contains four protons. The changes taking place when one atomic species is bombarded by another can then be indicated by equations, in much the same way as the chemist is accustomed to indicate the reactions between atoms in order to form molecules.

As an example, consider the equation

$${}_4Be^9 + {}_2He^4 \rightarrow {}_6C^{13} \rightarrow {}_6C^{12} + {}_0n^1$$

This expresses the fact that, when a target containing beryllium is bombarded with alpha-particles or high-speed helium nuclei, in some cases the alpha-particle will be caught and fused in with the beryllium nucleus, giving temporarily an "excited" (or surplus-energy-containing) nucleus of the isotope of carbon which contains seven neutrons and six protons in its nucleus. Reference to Figure 2 shows that this is a kind that occurs stably in nature, but here it is formed with so much excess energy that it is not stable and very quickly (without any measurable delay) breaks up, as indicated, into a carbon nucleus of atomic weight 12 and a neutron. This particular equation is historically important, as it corresponds to the process by which neutrons were first discovered by Prof. J. Chadwick, who was then at the Cavendish Laboratory at Cambridge University, England.

There are quite a number of reactions of this same type, in which, when an element is bombarded with alpha-particles, the alpha-particle is captured and a neutron is emitted. Evidently the product nucleus thereby formed has two more protons but only one more neutron than the original nucleus, and this tends to make it too rich in protons; that is, tends to put it on the side of the stable elements in Figure 2 where the positron emitters lie. It was, in fact, through the study of reactions of this type that this kind of artificial radio-activity was discovered in 1934 by Irène Curie and her husband, F. Joliot.

PROCESSES of just the opposite type were discovered and first studied by Fermi and his colleagues at the University of Rome. He bombarded targets with fast neutrons and found that alpha-particles were emitted. The first reaction of this type was studied by Feather, who found that boron (B) is produced from nitrogen (N) by bombarding with fast neutrons. The equation is

$${}_7N^{14} + {}_0n^1 \rightarrow {}_7N^{15} \rightarrow {}_5B^{11} + {}_2He^4$$

As it happens, in this case as in several others, the nucleus produced is a stable one. But in this reaction the net change from the struck to the product nucleus is to rob it of two protons while taking away only one neutron. This change tends to make the product lie outside the group of stable elements of Figure 2, and in such a way as to leave the product having too many neutrons. Therefore, one might expect sometimes to produce unstable elements in this way, and that when he did so they would always be the kind which emit electrons and not positrons. That is exactly what Fermi and his associates found.

Now we may consider a specific instance of a radio-active element that is formed in two different ways. Thus, for example, Fermi found a reaction of the type just considered when phosphorus (P) was bombarded by fast neutrons to give radio-aluminum,

$${}_{15}P^{31} + {}_0n^1 \rightarrow {}_{13}Al^{28} + {}_2He^4$$

The aluminum atoms of this variety are unstable (ordinary aluminum is ${}_{13}Al^{27}$) and disintegrate by converting one of their neutrons into a proton with ejection of an electron. This process happens at such a rate that the average "life" of such an aluminum atom before it is converted into a silicon atom is 137 seconds.

On the other hand this same kind of radio-active aluminum may also be produced by bombarding aluminum of the ordinary kind with neutrons. In this case the neutron is simply captured on striking the aluminum nucleus, according to the reaction

$${}_{13}Al^{27} + {}_0n^1 \rightarrow {}_{13}Al^{28}$$

The radio-aluminum produced in this way is found to disintegrate in the same way as the other and in all respects seems to be the same stuff.

Direct Current Super-Power

Is High Tension D.C. Transmission Coming Soon? . . . Engineer Discusses Its Advantages . . . Awaits Only Perfection of Apparatus . . . Almost Ready

POINTING out that power use in this country has increased ten-fold in less than 18 years, J. D. Ross predicted in a recent address before the Engineers' Club of Seattle a similar further increase in less than 20 years (to more than a thousand million kilowatt-hours) and advocated inter-tying the great federal plants in the country with a network of direct-current transmission lines. Bonneville, Grand Coulee, Boulder, TVA, and the "million horsepower" Skagit, of Seattle, are foundation stones for this super-power era. Power from these plants, from great hydro and steam plants yet to be built, would be distributed on transmission lines a thousand or more miles long cross-cutting the nation at intervals of 250 to 500 miles.

Direct-current transmission now awaits only the development, in enormously increased capacity, of tubes similar to those small ones now made for radio. These tubes would be used as rectifiers to convert A.C., after its generation and stepping up to a high voltage, into D.C. Then at the receiving end, other tubes would convert the power into A.C. again so as not to disturb existing community systems.

The present method of transmission using A.C. is subject to severe limitations, one of the most important of which is an electrical effect which causes great loss of power but which does not affect D.C. transmission. Hence "the practical transmission distance for A.C. for very large blocks of power seems to be about 300 miles," said Mr. Ross. He then contrasted A.C. and D.C. by means of a specific example. "An ordinary three-phase A.C. circuit that will transmit 48,000 kilowatts 300 miles with 5.66 percent power loss, if used with D.C. with one wire removed, will transmit 68,500 kilowatts with the same percentage loss. This means that a two-wire D.C. line will deliver 43 percent more power than the three wires of an A.C. line, using the same size conductor and the same insulation. With longer distances, the comparison is still more favorable to D.C. transmission.

"It is customary, in order to insure continuity of service, that duplicate lines be used. Ordinarily that would require four wires. Here comes a tremendous saving in cost. By making one wire positive to earth and one wire negative to earth, we can use one wire for each circuit, and use only two wires instead of four. . . .

"Two such circuits of only one wire each would deliver 684,000 kilowatts per wire 100 miles away, or a total of 1,368,000 kilowatts. If these two wires reached from the Columbia River to Chicago, they would deliver in Chicago about 760,000 kilowatts. If the voltage of each wire were raised from 400,000 to 500,000 volts, the wires would deliver Chicago's total need of 1,000,000 kilowatts.

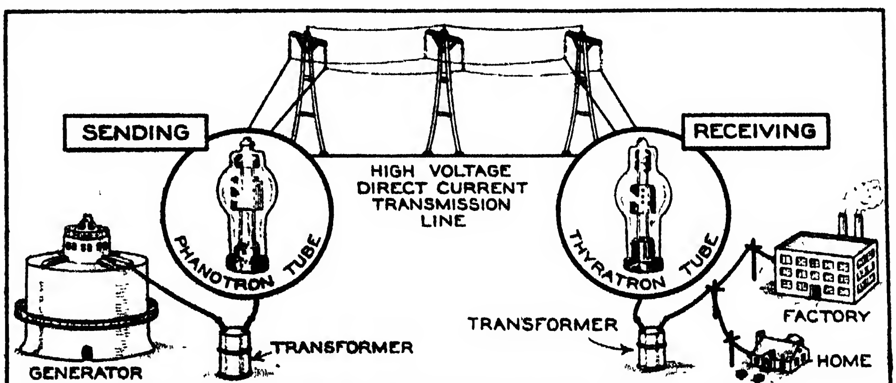
"IF the wires were carried on to New York at 400,000 volts, the Columbia River would deliver to that city about 516,000 kilowatts. If the voltage were raised to 700,000, the wires would deliver New York's demand of 1,500,000 kilowatts."

The apparatus for rectifying the high voltages necessary for D.C. transmission "will be slowly perfected over the next few years," predicted Mr. Ross. "Some of our brightest engineers are hard at work on this problem. Already it is possible to use three 50,000-volt rectifiers in series, delivering 150,000 volts (D.C.) on the transmission line. What we need, however, for 1000- or 2000-mile lines is not 150,000 volts, but 400,000 or 500,000 volts, or higher."

Mr. Ross said further that with the coming of D.C. transmission, huge generators with higher efficiency will make their appearance. Treated poles, instead of towers, would be used to carry the wires. The saving in copper due to the use of fewer wires or cables would partly be offset by the high cost of the tubes at each end of the circuit. However, the fact that the generating can be done at the source of cheapest power will bring a much lower generating cost so that the cost of electricity to the consumer can be lowered.

The system now proposed contemplates use of most if not all the undeveloped water power totalling, according to the United States Geological Survey, over 52 million kilowatts, and the construction of steam power plants near coal mines and in lignite fields. The coal reserves of the nation are estimated at about three thousand billion tons, and there are enormous lignite fields in Dakota and in Texas. On the average, each pound of coal will produce one kilowatt hour, while low grade lignite will produce somewhat less than one kilowatt-hour per pound. Utilization of these sources together will, however, supply the demand for electricity for many years to come, the drain on no one of them being unreasonable.

But what are the economic possibilities of D.C. transmission? Costs throughout the country would be largely equalized. There will be no isolated power plants. Irrigation and manufacture could be carried on with equal ease in any part of America, whether it be in the dust bowl or on tidewater. Industries could be located anywhere and congested areas could be decentralized. Most important, perhaps, is the fact that power could be delivered from a distance of 1000 miles at about the cost we get it from 100 miles distance today. In addition, the greater flexibility of transmission, allowing huge amounts of electricity to be sent over long distances by D.C., will tend to promote greater use.



Alternating current is stepped up to a high voltage, converted into direct current with a tube, then re-converted to alternating current at the point of use

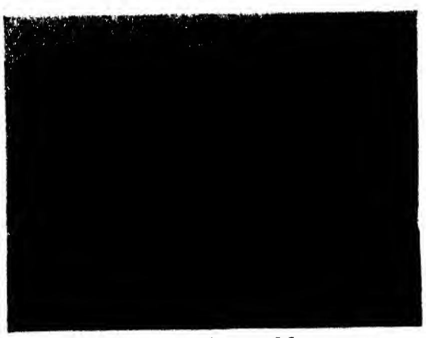
SCIENCE AND INDUSTRY

A MONTHLY DIGEST

TRACTOR FOR COMFORT

HAVE you heard the latest one about this farmer's daughter? Well, her Old Man got one of those new Minneapolis-Moline de luxe tractors and she did all the plowing. Reason enough: the tractor has all the comforts of home—and a few others besides.

Radio; self-starter; an enclosed, all-steel cab; safety glass; comfortable, cushioned seats for two; complete lighting system; self-energizing brakes—it has them all. Furthermore, it is lined with sound-absorbing material, and is air-ventilated. Temperature is controlled with a hot-water heater in winter and air circulation in summer.



All the comforts of home

The new vehicle amounts to a dual piece of equipment for it can haul plows and harrows in the field or roll along the highway as a truck, pulling a heavy trailer-load of produce to market at 40 miles an hour. Capable of pulling four 14-inch bottoms in average soil, it has a maximum draw-bar pull of 5270 pounds in low gear. It has five speeds forward and one reverse.

SPECIALISTS SHOULD ADVISE ON HEARING AIDS

DEAFENED persons should seek the advice of doctors specializing in ear diseases when they choose hearing aids, Drs. Horace Newhart and Henry E. Hartig of Minneapolis stated recently. They warned against "racketeering instrument salesmen" who "exact high prices for instruments which rapidly wear out, batteries which run down quickly, and provide no means for servicing the instrument in order to keep up its efficiency."

The final test of a hearing aid is intelligible, clear speech. Magnifying all sounds for people who are only deficient in certain parts of the scale creates unbearable noise, the two doctors pointed out. Ear specialists can check on this point and also can advise the kind of hearing aid needed by those deafened persons who require sound conduction through the bone back of the ear drum in order to hear.

One guard against the "racketeering instrument salesmen" is seen in the standards for hearing aids set by the American Medical Association, standards to which all reputable manufacturers now adhere.—*Science Service.*

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

NEW FLAME-PROOFING COMPOUNDS

THE ammonium salt of sulfamic acid is a valuable flame-proofing agent for use on fabrics, paper, and other combustible materials. It has the advantage of causing no stiffening of fabrics to which it is applied, nor does it effloresce and whiten the surface. Fabrics treated with it can be dry cleaned without losing their resistance to flames.

Sulfamic acid is made by dissolving urea in sulfuric acid and adding sulfur trioxide. It is now produced on a commercial scale. —*D. H. K.*

NIGHT BLINDNESS DETERMINER

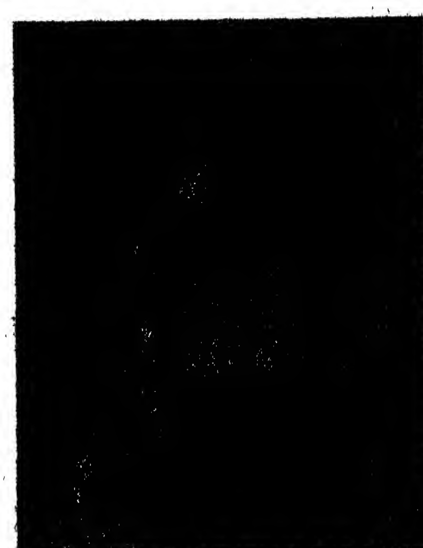
A NEW scientific instrument requiring only eight minutes to ascertain whether a person is deficient in vitamin A and afflicted with night blindness, now recognized as a major factor in night auto accidents, has been announced by the American Optical Company. Clinically tested and approved, this instrument, called the Adaptometer, is the first ever developed to detect night blindness in a few minutes.

Night blindness is the inability of the eye to adapt itself to dim light. It was responsible, according to Dr. J. F. Neumueller, director of the optical company's bureau of visual science, for many of 1936's 22,000 auto fatalities which occurred during hours of darkness when only 20 percent of the total traffic was on the road.

It is claimed the Adaptometer with its quick and sure test for vitamin-A deficiency will be of great value to doctors, eye authorities, school dietitians, the Army and Navy, industrial concerns, transportation companies, insurance firms, railroads, air transportation companies, and motor vehicle commissions.

Night blindness is definitely associated with various organic and functional disorders, Dr. Neumueller stated. It is usually caused by a deficiency of vitamin A. This essential vitamin is called upon by Nature to regenerate visual purple, a substance found in the retina of the eye and necessary for seeing in dim light. Exposure to glare or strong light bleaches out the visual purple. A partial blind period results, lasting until the regenerative process restores the retina to normal.

The operation of the Adaptometer is quite simple. The subject is seated in a dark room facing the instrument. His eyes are fixed on a strong light in the upper part of the in-



To detect night blindness

strument. This light bleaches out the visual purple in his retina. After a three-minute exposure, the bright light is turned off and the subject is apparently in complete darkness.

However, when the bright light is switched off a very weak test light is automatically switched on. The test light becomes visible to the subject only after sufficient regeneration of visual purple. The time of regeneration in normal cases should not exceed five minutes. If a longer time is needed, the subject is considered deficient in vitamin A and has night blindness.

Hard Crystals from Boric Acid

PERVERSENESS of scientific research and laboratory use of a tin can gave to the world recently a new dress for an old substance, changing boric oxide from a glass to a crystal as hard as rock.

This new member of the crystal family has the same fundamental chemical properties as the boric acid from which are made eye washes and antiseptics, but it promises new controls in the manufacture of glass.

Scientists had sought in vain for years to discover a formula to change the glassy oxide to a crystal. They had used elaborate laboratory paraphernalia and vacuums in their futile attempts. But it remained for Leon McCulloch, a research engineer and chemist in the Westinghouse Research Laboratories, to make the revolutionary discovery—all because one of his experiments turned out exactly contrary to his hoped-for result.

Mr. McCulloch was working with boric acid fused in loosely covered quart tin cans under atmospheric pressure in an oven which was heated to between 225 and 250 degrees, Centigrade. "I wanted the mixture to stay liquid so that it could be used to impregnate electrical coils, serve as insulation," he explained. "But the mixture turned white and milky, and then pasty. Finally it became stone-like, something I had never seen happen before. In fact, it was something that no other scientist had ever recorded before."

The engineer "weighed" this strange mass. Its specific gravity was a third again as great as a similar lump of boric oxide glass. It was so hard that several blows of a hammer were required to shatter it. Its hardness was comparable with Portland cement.

Then he melted the mass and discovered that it had a definite melting point at 470 degrees, Centigrade. Its relative, boric oxide glass, has no definite melting point, making the transition from a solid to a liquid in a gradual process of heating.

First step in producing rock-hard crystals from powdery boric acid

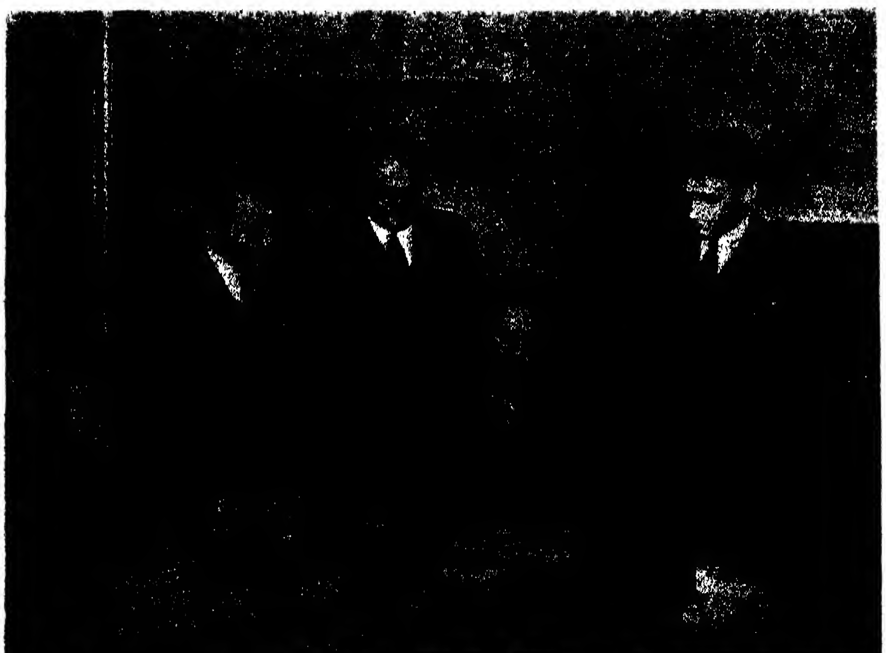
Mr. McCulloch also demonstrated that the new crystal could be prepared at temperatures around 250 degrees while the glass had to be fused at 900 degrees.

By adding "seed," or small pieces, from crystalline oxide previously obtained, Mr. McCulloch was able to induce boric acid fusions to crystallize immediately. "By this method," he explained, "the oxide can now be prepared in large quantities."

Repeated hammer blows are necessary to break boric oxide crystals

Boric oxide glass plays an important rôle in the chemical and industrial fields because of its high resistance to heat shock.

Because of its controllable melting point, the new laboratory discovery should prove helpful in commercial glass manufacture, supplanting boric oxide glass in a number of processes, Mr. McCulloch stated.



Three official witnesses certify to the packing of the Westinghouse Time Capsule, the "cross-section of our civilization" buried, for the benefit of archeologists of the year 6939 A.D., at the New York World's Fair. Grover Whalen, President of the Fair, signs the document which is to go into the capsule, while the other two witnesses—F. D. McHugh (left) of Scientific American and C. G. Weber (right) of the Bureau of Standards—await their turn. David S. Youngholm, Westinghouse vice president, stands behind Mr. Whalen. On the table before the group are some of the numerous articles that went into the capsule, which hangs in the rear (left). The eight cans of films reproduce millions of words in print

Plastic Seals

LEAD seals used to prevent tampering with instruments, packages, freight cars, and so on, may be replaced by a new type of plastic seal now being used in Germany. The new seals have the advantage of being applied by hand without the use of tools; once in place they cannot be removed without destroying the seal.—*D. H. K.*

River in Submerged Grand Canyon of Pacific Coast

THE Pacific Coast's submerged Grand Canyon has a swift river that flows along its bottom, Prof. Francis P. Shepard of the University of Illinois has reported upon his return from an exploration of its course for 30 miles, off shore from Monterey, California.

The great submarine canyon [see also September, 1938, Scientific American.—Ed.] which goes to depths of 6000 feet and is actually contoured like the Grand Canyon of Arizona, causes a river-like flow by capturing and channeling ocean tides, Prof. Shepard discovered through the use of a current meter.—*Science Service.*

Slow Propellers for Stratosphere Planes

ACCORDING to Charles H. Chatfield of United Aircraft, speaking at the Fifth International Congress for Applied Mechanics, stratosphere airplanes will be equipped with propellers 20 feet in diameter or about twice the size of the airscrews in general use today.

The prediction is sound, and our readers

The *Brandenburg*; it has made significant ocean flights

may be interested in the scientific reasons which justify it. When the airfoil or the propeller blade approaches the speed of sound it loses lift and efficiency. But the speed of sound diminishes in air of low density, which is encountered at great altitudes. Therefore the "compressibility burble" effects of propeller tips revolving at high speed will be augmented in stratosphere flying. The remedy is to make the propellers revolve much more slowly. But if the speed of the propeller is much slower it will not be able to absorb the engine power.

Hence the logical conclusion: a propeller revolving much more slowly, but having a much greater diameter than the airscrews now being used on our transports.—*A. K.*

A Significant Ocean Flight

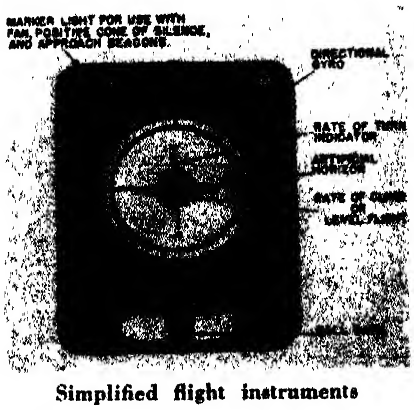
NON-STOP flights across the North Atlantic do not now carry the thrill that they once did. Corrigan was a nine days' wonder, but the memory of his flight will last but a fraction of the time that Lindbergh's exploit will continue to be recalled. The exploratory crossings of large seaplanes are taken for granted. The recent exploit of the Lufthansa Focke-Wulf Condor *Brandenburg*, on the other hand, has a special significance. It was the first non-stop flight between Berlin and New York, on the difficult westward crossing, in which contrary winds are the general rule. The *Brandenburg* is a landplane, and its flight will confirm many in the belief that multi-engined planes can be used for over ocean flying, particularly when it is intended to serve inland centers.

Records of this kind generally are achieved with specially constructed aircraft, but this great four-engined Condor was one of a fleet of Focke-Wulf machines ordered for the Lufthansa, and was to all intents and purposes in standard condition except for the extra fuel tanks installed to increase the range. On landing in New York it was discovered that an oil lead to one of the four engines had fractured. This delayed the return trip a day, but also showed that modern aircraft are much less handicapped by the occurrence of minor mishaps than the airplanes of a few years back. Finally, it is most significant that the flight was kept a complete mystery to the last, and that no reports were received from the crew during the entire two flights. The supposition is that the radio direction finding equipment on board the aircraft functioned admirably without aid from a special organization. This indicates far greater independence of radio aids to navigation than is generally believed to be possible.

To Americans the flights were gratifying for two reasons. The fine engines employed were Hornets, developed by Pratt & Whitney, even though built by the Bayerische Motro Werke in Germany. Secondly, the appearance of the trim looking *Brandenburg* is in every respect a derivative of American practice, although this in no way detracts from the credit of the German designers and constructors. After a certain stage of development has been passed, all vehicles of transportation tend to assume similar characteristics.—*A. K.*

Simplifying the Pilot's Task

NUMEROUS engineers and inventors have given thought to the problem of simplifying the airplane pilot's task by assembling the indications of a number of instruments at a single point of observation. It is gratifying to learn that the Sperry Gyroscope Company, which has developed so many instruments for the pilot to observe, has now brought out a practical method of



Simplified flight instruments

reducing the pilot's work along these lines. The device, termed the "Flightray," makes use of a cathode-ray tube, upon the luminous screen of which the various indications are assembled in a standard pattern. The multiple indicator reproduces indications from the artificial horizon, directional gyro, turn indicator, and altimeter. It may also be used to show position on the glide path and the localizer radio beam for instrument landing. The Flightray has undergone severe tests successfully at the Indianapolis Airport, and many blind landings were made using solely the indications of the Flightray. Pilots will give thanks when the instrument is available for service use.

The photograph gives an idea of the manner in which the instrument works. The horizon indications are shown in the conventional manner. The rate of turn is shown by side-to-side movements of the vertical bar. When the instrument is set to show level flight at cruising altitude, the concentric circle encloses the miniature airplane as long as level flight is maintained, and the position of the circle thus indicates deviations above or below the desired altitude. With the aid of a selector switch the Flightray may be changed from a flight indicator to a landing indicator.—*A. K.*

Women at the Air Races

OUR readers must have been pretty well jaded with the usual graphic newspaper accounts of the National Air Races, so we will not risk boredom by telling of the records achieved, of the dramatic way in

Miss Cochran, 1938 winner of the Bendix Trophy race, with Major de Seversky (right) and Ray Brown

which Roscoe Turner won the Thompson Trophy, and so on. But there are two things which will remain in our memory of this year's great Cleveland contests. One is the remarkable way in which women can beat men at the very masculine game of flying. The other concerns the flying characteristics of the Fieseler-Storch plane, which makes more poignant the regret that America has never taken kindly to the Handley-Page slot.

The Bendix Trophy, the classic transcontinental speed race since 1931, was won by Miss Jacqueline Cochran, famous pilot who flew a superb race from Burbank, California to Cleveland (covering the distance in 10 hours, 7 minutes, 10 seconds) and beat

nine competing men. She flew a Seversky single seater, powered with a Pratt & Whitney Twin Wasp engine. The Bendix Trophy and an important sum in cash were her rewards.

Again, in showing what a Handley-Page slot with flaps and proper design can do, Fräulein Hanna Reitsch, a diminutive young woman of 25, performed amazing acrobatics and astounded the general public and the experts by her ability to fly very slowly in perfect control and to land on the proverbial dime.

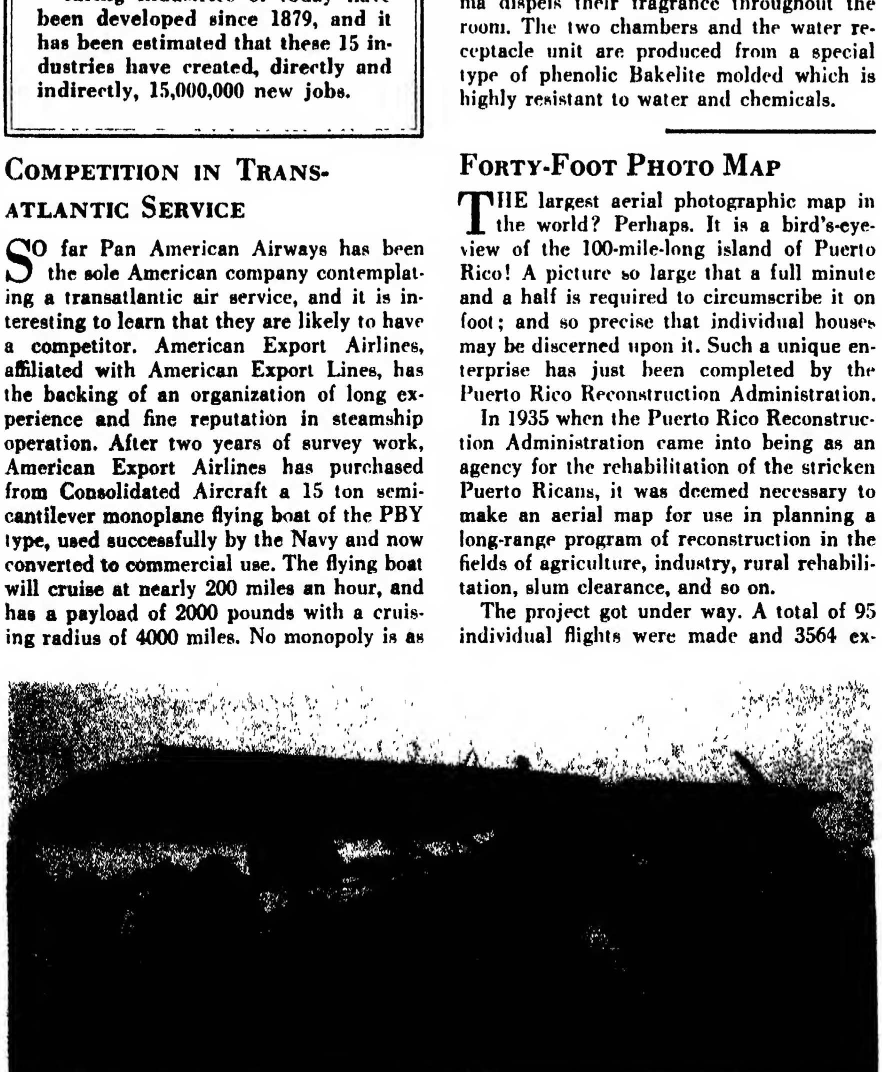
As shown in our photograph of the Fieseler-Storch ship, the slot or movable airfoil is placed ahead and along the entire length of the leading edge. The rear flap also runs the entire span of the wing. The combined effect of slot and flap is to decrease the stalling speed, to prevent "stalling," and to keep the ailerons perfectly effective under the slowest flight conditions. The Fieseler-Storch, a braced monoplane of German construction, is otherwise in no way remarkable, though it achieves a fair speed for its type and power. Perhaps Fräulein Reitsch's exhibition will revive interest in the utilization of such slots.—*A. K.*

JOBS

FIFTEEN of our major manufacturing industries of today have been developed since 1879, and it has been estimated that these 15 industries have created, directly and indirectly, 15,000,000 new jobs.

Competition in Transatlantic Service

SO far Pan American Airways has been the sole American company contemplating a transatlantic air service, and it is interesting to learn that they are likely to have a competitor. American Export Airlines, affiliated with American Export Lines, has the backing of an organization of long experience and fine reputation in steamship operation. After two years of survey work, American Export Airlines has purchased from Consolidated Aircraft a 15 ton semi-cantilever monoplane flying boat of the PBY type, used successfully by the Navy and now converted to commercial use. The flying boat will cruise at nearly 200 miles an hour, and has a payload of 2000 pounds with a cruising radius of 4000 miles. No monopoly is as satisfactory as competition between two or three efficient organizations; hence the aviation industry will probably welcome this newcomer in the field of air transport.—*A. K.*



The Fieseler-Storch; a German monoplane with slots and flaps, which recently created a sensation by its ability to fly and land slowly, under perfect control

Breathe Easier

THE Reidcraft Company has developed an ingenious device called the Airoma. It is employed for humidifying air within a room to alleviate colds and other respiratory afflictions such as laryngitis, croup, asthma, and hay fever. The Airoma consists of a glass water reservoir, an electric heating chamber, and a vapor chamber. Drops of medicated inhalants, pine fragrance, and other aromatics are put on a special cotton puff which is placed over the vapor chamber. The Airoma dispels their fragrance throughout the room. The two chambers and the water receptacle unit are produced from a special type of phenolic Bakelite molded which is highly resistant to water and chemicals.

Fragrance diffuser

Forty-Foot Photo Map

THE largest aerial photographic map in the world? Perhaps. It is a bird's-eye-view of the 100-mile-long island of Puerto Rico! A picture so large that a full minute and a half is required to circumscribe it on foot; and so precise that individual houses may be discerned upon it. Such a unique enterprise has just been completed by the Puerto Rico Reconstruction Administration.

In 1935 when the Puerto Rico Reconstruction Administration came into being as an agency for the rehabilitation of the stricken Puerto Ricans, it was deemed necessary to make an aerial map for use in planning a long-range program of reconstruction in the fields of agriculture, industry, rural rehabilitation, slum clearance, and so on.

The project got under way. A total of 95 individual flights were made and 3564 exposures taken. Precision work of the most involved and exact kind was carried on so that the photographic map would be, in every way, scientifically correct.

100 miles in 40 feet

Now, the picture is made, and the Puerto Rico Reconstruction Administration and other government agencies have at their disposal possibly one of the most interesting and valuable photographic products in the world. Costing about $69,000 to make, copies of the map are being made available to private concerns and parties for less than $300 each.

The uses of such maps are manifold. Valuable for the interpretation of agricultural, industrial, engineering and municipal problems, they also may be used for surveys of all kinds, for the location of high-tension power lines, the planning of reservoirs for water power, electrification and hydro-electric projects, harbor improvements, city planning, traffic surveying, flood control, and timber estimates.

The immeasurable value of the map for use in planning fortifications, in carrying on maneuvers, or in war time is self-apparent. Both the Army and the Navy are availing themselves of the possibilities of this map.

"Thermos Bottle" Air Conditioning

THE idea of churches being air conditioned by a giant Thermos bottle was discussed recently in Boston at the meeting of the Power Engineers Association at the Engineers Club.

Walter A. Grant, District Chief Engineer for Carrier Corporation, described this method as being ideally adapted because of the short periods during which churches are used.

"It appears self-evident," stated Mr. Grant, "that an application such as air conditioning a church for only a few services a week will permit the use of a very small refrigeration plant storing up cooling effect 24 hours per day for the six week days, and releasing all of this stored cold in a veritable avalanche for the relatively few hours of actual use.

"There are a number of similar applications," he continued, "where storage is the obvious solution. Under this heading come cafeterias operating just during noon hour.

This is the method used in the Carrier employes' cafeteria at the Syracuse plant. Also funeral parlors and certain classes of auditoriums can provide summer comfort with this system. Water is gradually cooled and stored in a large insulated tank that is virtually a Thermos bottle. This chilled water is then released to the air-conditioning system where the air is cooled to the desired temperature for comfort."

High School Students Study Eugenics

EUGENICS, including a study of venereal diseases, sterilization, attitude and fitness for marriage, is being taught to pupils in the high school at Blackfoot, Idaho, and in several other towns in Idaho.

The students like the course and think it practical, S. Edmund Stoddard, of the Blackfoot High School, reports to the journal *School and Society*.

Eugenics is taught as part of a course dealing with genetics and heredity, in which popular misconceptions concerning prenatal influences and sex determination are debunked and the students are allowed to observe the mechanism of heredity in plants and fruit flies. Each is required to work out charts showing the inheritance in his own family of two traits such as eye color, teeth abnormalities, or taste differences.

Venereal diseases are included in the studies because, although they are not hereditary, they are so readily transmitted from mother to child. Objection to the course has been made on the ground that high-school seniors are too immature for such discussions, Mr. Stoddard said. His reply is that high-school students are getting married and becoming parents. "It would seem a worth-while education for these young people to realize the responsibility of marriage and the vital rôle of inheritance, and also environment, in the rearing of their children," he said. "Certainly young married people should know the facts of marriage."
—*Science Service.*

Floating Home

SOME months ago we described in these pages an all-steel, all-welded house built by R. G. LeTourneau, Inc., which was built in the factory and then moved to its site on a trailer. Since that time 33 similar houses have been built and some of them have served as homes for employees of the company.

Recently home No. 1, after serving as a residence for a year and a half, was carried on a 16-wheel trailer to the river bank, lowered into the river by an 80-foot tractor-crane, and towed across the mile-wide Illinois River by a 27-foot, 60 horsepower motor launch. It was then set up on a new home site, none the worse for its voyage. Judging from the photographs, no extra work except partially boarding up the doors was necessary before the job of floating.


Courtesy Bakelite Corporation

Burning cigarettes, carelessly forgotten, will not drop from this ash tray to scar furniture, burn rugs. The heat from a lighted cigarette, as the ash grows long, will expand a spring which tilts the rest and dumps the cigarette into the tray

First Subway-Builder Honored

NEARLY 69 years ago, on February 26, 1870, the world's first subway was opened under Broadway, New York City, extending one block south from Warren to Murray Streets. For three years thereafter, the chief "sight" of the city was the "ride" under Broadway for a quarter, the proceeds of which were donated to charity.

Recently, on its "Famous Firsts" program, radio station WOR honored the pioneering Editor of Scientific American, Mr. Alfred Ely Beach, for his invention of the tunnelling shield that drove this nine-foot tube only 10 feet below the cobblestone surface of the thoroughfare; shields based on this same principle have bored all subaqueous tunnels ever since, including the famous Blackwall Tunnel under the Thames River at London, England.

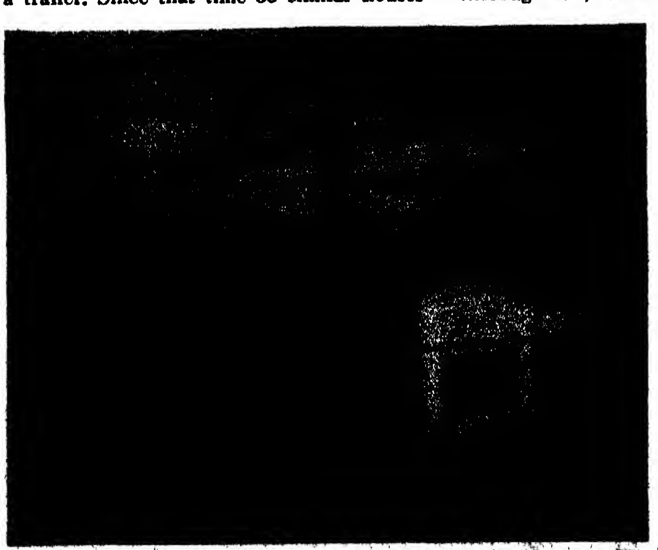
Visitors to the Edison-Ford Museum at Dearborn, Michigan, can see today the Beach Shield (which was removed from its 45-year resting place in 1912) with its hydraulic jacks or rams that, bearing against the end of the completed tunnel, pushed the cutting edge forward through the earth, directing it around a curve by exerting greater pressure on the outer edge. As the Beach Pneumatic Transit Co., under its franchise to lay pneumatic tubes to convey mail the entire length of Manhattan Island, as well as under the rivers, was not allowed to dig up the streets —"the walls of the Astor House would fall and dire calamity would follow"—Editor Beach experimented with a four-foot shield of wood. Finding that it would work and that he could direct it, he boldly drove a nine-foot tube.

SENSITIVITY

A GALVANOMETER that will detect a current variation of a ten-trillionth of an ampere, has been built at the Smithsonian Institution. Twenty times more sensitive than any heretofore used, this instrument, together with a thermocouple, will make available to astronomers data from which can be deduced hitherto unobtainable information on the structure of luminous bodies in far distant space.

Hydrogen in Bulk

THE increasing use of hydrogen in chemical manufacture, particularly for the synthesis of ammonia and the hydrogenation of coal and oils, has put production on a huge scale. Although no less than 25 different methods have been used at one time or another in the production of hydrogen, only three are of present substantial importance. These are the complete gasification of coal, coke, lignite or other carbonaceous materials by the water-gas and producer-gas processes; the separation of hydrogen from coke-oven gas by low-temperature liquefaction plants; and the electrolysis of water. The first of




A welded steel house is lowered into the Illinois River and, *right*, towed to its new home site

these accounts for approximately 55 percent of the total hydrogen produced, the second for about 26 percent, and the third for 16 percent. In the United States, hydrogen is produced principally by the water-gas process and by electrolysis.—*D. H. K.*

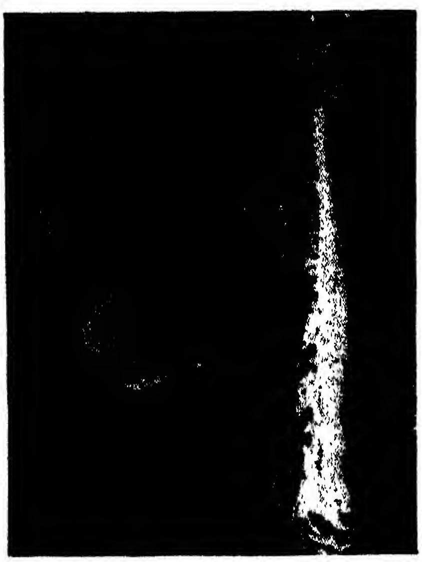
SMOKE

THE visible part of the smoke emitted from one cigarette weighs .0031 of an ounce. By puffing 322 cigarettes, it is possible to make enough smoke to weigh one ounce.

Freezing Needle for Chilling Beef

WITH the advent of refrigeration and the refrigerator car, the modern packing industry might be said to have had its birth. Today the housewife anywhere in the United States and in most foreign countries can have fresh meat for her table all year 'round.

Now another invention in refrigeration, developed by two Wilson & Company employes, makes possible an improved method of chilling heavy beef carcasses to insure finer quality beef.



How the new freezing needle is inserted into a heavy beef carcass

For many years meat packers have been confronted with the problem of getting refrigeration into the interior of the round on heavy beef carcasses. Because of the large bulk of the round and its covering of fat, the interior of the rounds frequently soured because they did not chill sufficiently rapidly to stop bacterial action.

Laboratory tests demonstrated that bacterial action in beef can be retarded at 50 degrees to 55 degrees, Fahrenheit. Tests have further shown that where the cooler temperature was 28 degrees to 32 degrees, Fahrenheit, the temperature inside the round was still 79 degrees, Fahrenheit, after 12 hours in the cooler.

A unique invention, developed and patented by John Malone, beef division superintendent of the Wilson & Co. Chicago plant, jointly with Adam Young, beef dressing foreman in the same plant, and now being used by Wilson & Co., has effectively solved the problem. The invention consists of a hollow, stainless steel needle through which flows a regulatable stream of cold brine. The needle has a length of 17½ inches from base to tip, and a solid sharp point which permits insertion into the beef hind quarter to make direct contact with the hip joint region where bacterial action is most likely to occur if the temperature is not rapidly brought down to 50 degrees, Fahrenheit, or lower within 12 hours after the animal is slaughtered.

Commercial beef-freezing set-up

Full and uniform circulation of the brine through the needle is assured by the inner tube assembly. Inside of the outer needle is a stainless steel tube which fits into the base and body of the needle to direct the flow of in-coming brine to the point of the needle. From the point, the brine flows back between the walls of the needle and the inner tube to an outlet in the base. The inlet and outlet connections of the needle are joined with the cooler brine lines by flexible hose lines which permit considerable freedom of motion in the insertion and withdrawal of the needle. Petcocks permit stoppage of brine flow through the needles when they are not in use.

With the use of these new needles, cooler temperatures need not be lower than 32 degrees, Fahrenheit, which means that there are savings in the cost of refrigeration, as well as protection against souring in the rounds.

This invention is another step in insuring finer quality meat for the American consumer, and is an example of the constant refinements in meat packing being brought about through scientific research by large packers. It is this constant scientific research which assures that the meat supply of the American housewife will be the finest obtainable.

Resin Plasticizer in Lubricants

LUBRICANTS can be improved and made resistant to high temperatures by the addition of dibutyl phthalate, a material used to soften resins, and a resin as a thickener. Resistance to carbonization at high temperatures and good lubricating and viscosity characteristics are claimed for the mixture. A typical blend consists of mineral oil, 16 parts; dibutyl phthalate, 3 parts; and polyvinyl acetate, 1 part.—*D. H. K.*

LOCOMOTIVES

IF coupled together, all the locomotives and cars owned by the railroads of the United States would make a train approximately 20,000 miles long.

Unique Heat Treating Method

RESEARCH conducted during the last four years by the Monarch Machine Tool Company has resulted in the development of a process which permits selective heat treatment of the ways of large lathe beds without the necessity of building a furnace of sufficient size to accommodate the entire casting. By the new method, no furnace at all is required, the heating and quenching being carried out in one operation by means of a specially designed oxy-acetylene torch equipped with a series of water jets for quenching, which follow immediately behind the burner tip. In this

Heat-treating lathe-bed ways without a furnace

flame-hardening process, the lathe bed is immersed in a tank of water to a point just below the ways and a motor-driven mechanism then draws the heating and quenching unit at a uniform speed over the ways. Only one pass over the bed is required. The rate of travel of the burner tips over the bed ways depends on the thickness of the bed, varying from three to six inches per minute.

Test trips corresponding to the different sections of ways are used to determine the proper burner tips, the amount of heat to be applied and the rate of travel. The depth of penetration of the hardened surface can be varied from ⅛ inch to ¼ inch and the Brinell hardness is raised from 225/240 "as-cast" up to 575/590 after this treatment.

The nickel-chromium cast iron employed in Monarch lathes, aside from its other desirable properties such as high strength, rigidity, and machinability, is admirably adapted to this unique method of heat treatment. Nickel lowers the critical range, thereby permitting hardening at a lower quenching temperature than if plain cast iron were used, and tending to "blend" the hardened surface gradually into the core, hence minimizing troubles which might result from a too sharp line of demarcation between the surface and the unhardened interior portion of the casting.—*Nickel Cast Iron News.*

Treating Dairy Wastes

By adding a tanning agent to the waste waters from dairies, the proteins are coagulated and putrefaction is prevented. This new process is being applied in Denmark. Chrome alum and similar mineral tanning agents are used and relatively small quantities will serve the purpose. The dosage must be regulated according to the concentration and nature of the waste water. A little over an ounce of chrome alum per 100 gallons of waste water is effective.—*D. H. K.*

"Jitterbug" Swings Three Tons Twelve Feet in Air

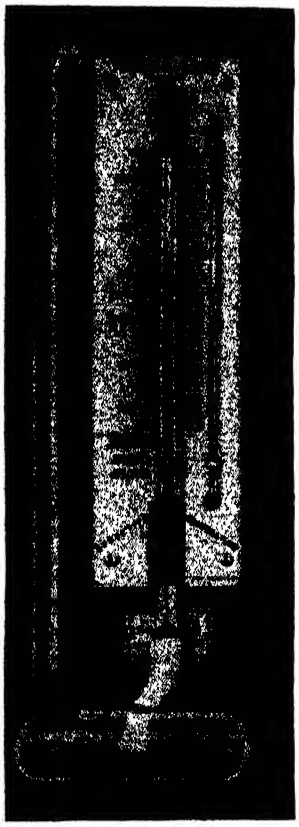
"Jitterbugs" are usually associated with "swing." That's why R. C. Howell, Cleveland engineer, decided on the name "Jitterbug" when he perfected a new type of Howell industrial truck which will swing a load up to 6000 pounds from a factory floor up to a height of nearly 12 feet, with

Mechanical "Jitterbug"

the greatest of ease. The "Jitterbug" can be driven right into a box-car and will load up a height of six feet, without using telescoping frames which nearly double the height to which it can load. Both the pay-load and the weight of the truck are carried on dead axles and on the 12-ply, heavy duty, General, industrial truck tires.

Direct Reading Effective Temperature "Meter"

WITH the rapid expansion of air conditioning it has become increasingly necessary to determine something more than mere temperature and humidity of the air in a room. Effective temperature is more important than either, yet it is determined by a consideration of both these other factors. Effective temperature is an arbitrary index of the degree of warmth or cold felt by the human body in response to heat, humidity, and air motion.



Effective temperature read directly

Any student of physics knows that it is a simple matter to determine the percentage of humidity in any given space by taking readings of a wet bulb thermometer and a dry bulb thermometer and then, by using the two readings, finding the percentage of humidity on a large chart. This method is too indirect for all practical purposes, so the Bailey-Parsons Therhumiter has been worked out to give not only a direct reading of humidity but also the effective temperature.

The accompanying illustration shows the Therhumiter with a center column ending at the bottom in two communicating bulbs containing red spirits. The upper bulb is responsive to heat (air temperature) only, the lower bulb is responsive to relative humidity and air motion. The result is registered on the scale above as a composite value indicat-

ing effective temperature directly. Two diamond-shaped areas on the scale represent the winter and summer comfort zones with 70 degrees effective temperature the optimum for winter and 76 degrees for summer. The wick of the wet bulb is kept saturated by immersion in the lower reservoir. A uniform water level is maintained by a removable, automatic-feed reservoir standing upright at the left, with its open end inserted into the lower reservoir.

The separate, blue thermometer on the right indicates air temperatures only.

Relative humidity is quickly determined by this simple formula, engraved on the scale: Normal humidity (50 percent saturation)—Red level with Blue. High humidity—Red above Blue—50 percent plus 8 percent per degree difference. Low humidity—Red below Blue—50 percent minus 8 percent per degree difference. This formula is based on moderate air movement. In still air deduct one degree from Red before calculating relative humidity.

Electrolytic Production of Lead and Sulfur

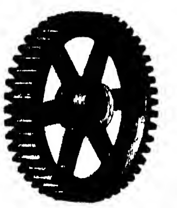
By electrolyzing a solution of galena (the ordinary lead-sulfide ore) in molten lead chloride, both lead and sulfur are produced simultaneously. The concentration used may be as great as 25 percent by weight of galena in the fused lead-chloride bath. Before solution, the galena is broken to relatively small sized particles, and impurities present are removed by concentration processes.—*D. H. K.*

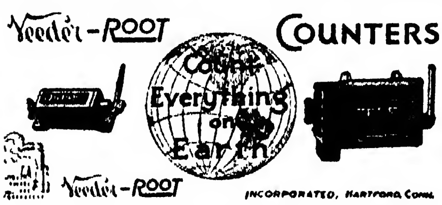
Portable Home Electric Ironer

In the past most women have been somewhat frightened at the numerous mechanical gadgets on a stationary type of home ironer. They have in many cases not been sufficiently interested to go through the training period necessary to get full efficiency with one of the larger ironers. Now with the Handee, developed by the Chicago Wheel and Manufacturing Company, it is claimed that even a 10-year-old girl can iron efficiently without previous experience.

But its simplicity is only one of its advantages. The Handee is portable and may be used anywhere in the house where there

Simple, portable, inexpensive





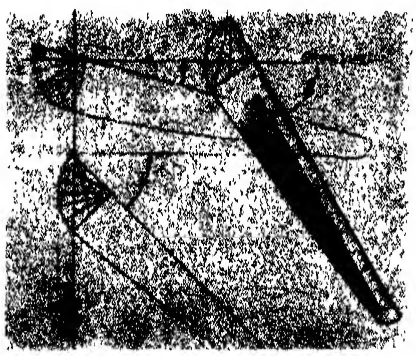
is an A.C. electric socket. A third point is its very low price—claimed by the manufacturer as being the lowest ever placed upon a quality rotary ironer.

The Handee weighs only 25 pounds. It has just two controls—a simple switch which turns on the heat and a motor control operated by the elbow so that both hands are free to handle the clothes being ironed. It will iron anything from a handkerchief to a sheet.

Pocket Drafting Instrument

A NEW pocket device known as the U-Draft pocket "drafting machine" has been put on the market by L. G. Wright, Inc. This instrument combines T-square, triangles, and drafting scales in a unique combination so that the instrument literally is a pocket-size drafting machine. It is 7½ inches long over-all and 1¼ inches wide.

The instrument consists of a graduated scale and a protractor head on which lines



Drafting instruments combined

are inscribed at 15 degree angles to the horizontal scale. The instrument is made of pyroxlin; all the scales are engine-divided. A metal stiffener, eyeleted to the pyroxlin, keeps the instrument flat.

It is possible to make with this device an accurate drawing six inches by six inches on any kind of paper. With it, angles 15 degrees apart may be drawn and all lines may be drawn accurately to length. It is supplied in four different graduations.

The tool is suitable for all types of mechanical drawings, cabinet drawings, installation diagrams, mathematical solutions, graphical calculations, floor plans, lettering, layouts, quick sketches, and dimensioning on larger drawings.

Where to Find Sunlight

"IF what you want is sunlight, live either at the North or South Pole, not at the Equator," is the advice of illumination engineers, judging from a study recently completed by Frank Benford and John F. Bock, of the General Electric Company. The poles receive 65 hours more sunlight a year than does the equator, their study reveals.

The explanation is that the earth's atmosphere refracts the sun's rays, so that the sun is visible even when it is below the horizon. At the equator this increase amounts to 40 hours a year, compared with 105 hours at the poles.

More close to home, they found that the south side of a building in New York City,

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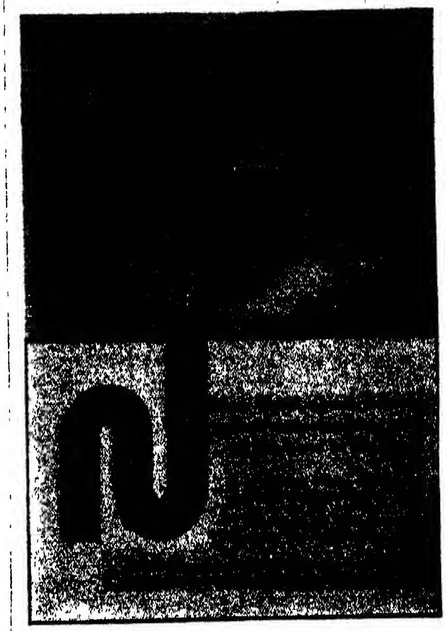
or other places in like latitude, annually receives 4½ times as much sunlight as does the north side. The north side receives 800 hours of direct sunlight each year; the south side receives 3600 hours. Effects of fog and clouds are not taken into consideration in the study, however.

FUME-LESS DRAIN-OPENER

IMPROVEMENTS resulting from extensive laboratory experimentation have been made in a widely-used chemical drain-pipe-opener for household use. According to the manufacturers, the fumes caused by the product's action are now absorbed before they emerge from the drain. Also, the action



takes place in the bottom of the trap where grease and other refuse frequently collect into a solid mass, and is not dissipated at the top of the pipe as happens with old-fashioned drain cleaners.

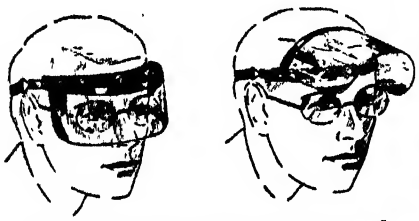
Most cases of stopped or slowed-up drains can be traced to an accumulation of greasy muck in the trap. Hair, coffee grounds, soap, garbage, lint, even scouring powders, are likely to be found in the clogging mass. This improved drain cleaner removes these substances efficiently and economically. A cup of cold water is first poured into the drain, then a little of the drain cleaner. Heat is quickly produced. At the same time, a stirring action occurs. The heat and agitation melt and loosen the hard, greasy muck, turning it into a soft mass that water easily flushes away. The amount of heat and agitation produced depend on a closely-controlled chemical formula that is the secret of the product's effectiveness.

EYE PROTECTION

SAFETY engineers, personnel directors, and production officials will be interested in a new eye protection device designed for general industrial use, having the advantages of lightness, wide range of vision, and generous ventilation.

The Jackson Type C Eyeshield consists of a flexible, transparent, non-inflammable visor obtainable in clear, smoked, light green, dark green or amber shades, adjustably hinged to a light headgear. No part of it rests on the nose or ears, making it very comfortable to wear. It does not interfere with the mechan-

ic's eye-glasses, if he wears them. Ample ventilation eliminates fogging. Hot metal rolls off this visor without marking it. This shield provides ideal protection for workmen engaged in soldering; flash, gun, and spot welding operations; for welders' helpers; for general



Eye protection that may be used either with or without eye-glasses

eye protection in industrial plants; for use in chipping operations; and in many other cases where the workman's eyes must be protected from flying particles.

A smaller eyeshield, available in the same shades, has many industrial uses and is said to be gaining popularity for sports wear and for the protection of motor car and truck drivers from sun and road glare.

Living Storage: Strange System of Honeypot Ants

There are ants in Central Australia which use the bodies of their fellows as a living storehouse for honey. They are among the many rare and curious specimens brought back by a well-known naturalist, Charles Barrett.

Just ordinary black ants in appearance, they yet have this unique habit of storing honey, surely among the most extraordinary of nature's many queer provisions.

How they choose the fortunate or unfortunate creature which is to spend the rest of its days inert, a mere helpless bag of sweetness, is not known. Seemingly any member of the community is eligible. Once selected, the workers bring to it their daily grains of nectar. The "honey-pots" swallow the nectar but keep it for the general use of the colony. They have two stomachs, a private and a communal one.

When a member wants nourishment it caresses the honey pot with its antennae and the living pantry passes out from its mouth a drop of the desired food.

As the body swells, the ant takes on the appearance of a shiny deep-toned cherry. Head and thorax remain unaltered, and so the insect looks ludicrously disproportioned. Aborigines call the honey ant "Yarumpa," and eat it alive as a delicacy.

Stockings Made of Castor Oil, Coal

Castor oil and coal appear to be the "silkworm" from which the silk stockings American women will wear tomorrow may be made. With these basic ingredients, chemists are now fashioning, in their test tubes, a viscous fluid which can be drawn into fibers that are finer and stronger than natural silk and have amazing elasticity.

While not yet ready for commercial production, chemists studying the new fibers aim at the goal of producing sheerer two-

thread stockings that will have the durability of four-thread hose.

In the posthumous patent of the brilliant du Pont chemist, Dr. Wallace Hume Carothers, just granted by the U. S. Patent Office, is revealed this strange fiber that gives promise of being silk's crucial rival in the hosiery field. The new patent's implications to a nation like Japan producing the great bulk of the world's natural silk, are not to be overlooked. When and if the chemists decide to bring the new product out of the laboratory, America, with its vast supplies of coal, will be a step nearer freedom from foreign domination of its silk requirements.

The new silk is not rayon, for its origin is not from the cellulose of growing plants like cotton or wood, but from coal and its highly important coal-tar derivatives. Coal tar has already produced thousands of organic compounds that range from perfumes which nature never knew to explosives and dyes and even to organic compounds of the human body itself, one of which is called cadaverine.

Out of sticky black tar, formed as coal is heated and its vapor caught by distillation, a long series of steps can duplicate cadaverine. It is by this completely synthetic method that Dr. Carothers prepared his material from which the silk-rivaling fibers come.

Castor oil enters into production of the new fiber because it is used to form an acid which is reacted with the cadaverine. This is sebacic acid. To make it, chemists first make a castor oil soap (just as soaps are made out of palm oil and other vegetable oils). Heating this castor oil soap with sodium hydroxide creates sebacic acid.—Copyright 1938 by *Science Service.*

NEW QUARTZ ULTRA-VIOLET LAMP

THE Hanovia Chemical and Manufacturing Company has perfected a new and more efficient lamp for producing intense ultra-violet radiations. This is a self-lighting quartz-mercury vapor arc, operating from alternating current thru a reactive transformer.

"Burner" of new ultra-violet lamp

The apparatus is small, of compact construction, inexpensive to purchase and maintain.

Measurements show an ultra-violet intensity of 6000 micro-watts of radiations of 3130 Angstrom units and shorter, at a distance of three inches. The spectrum is characteristic of the high pressure, quartz-mercury arc. The quartz "burner" is "C" shaped, the use-

ful arc being 1½ inches in length by half an inch in width. The burner can be operated in any position and is not affected by shocks or jars unless these are of sufficient intensity to fracture the quartz tube.

The "S" 100 burner, as it is termed, uses only about 100 watts of power. Tests show that after a thousand hours of service the burner still provides an average of 75 percent of initial intensity.

The new lamp also differs from the old type of mercury arc in that there are no pools of fluid mercury. Only a small amount of mercury is in the tube and this is all vaporized when the burner is in operation.

The burner envelope is made of clear fused quartz which has a far greater efficiency in transmitting ultra-violet radiations than even the best of expensive chemical glass. Quartz also does not readily exhibit the solarizing characteristics of glass. Fused quartz withstands temperatures where glass would melt. The new lamp has many commercial uses in addition to being a therapeutic source of ultra-violet radiations for home use.

Mysterious Springs— Night and First-Frost Types

In two recent numbers this department has contained the explanations of two types of intermittent springs, the cold syphon type and the barometric type, written by the United States Weather Bureau meteorological physicist Prof. W. J. Humphreys, author of standard treatises on peculiar atmospheric and cognate phenomena. Two remaining types, night springs and first-frost springs, are explained by Prof. Humphreys as follows:

"Often in the summer time, and especially in dry weather, a weak spring in a deciduous forest runs well at night but feebly, or even not at all, between nine o'clock in the morning and sundown. This is because the ground-water at such localities, as indeed in practically all localities, has two outlets, or two ways of escape, one by seepage and vein-like drainage to springs; the other through evaporation from the myriads of leaves overhead. When evaporation is least, as it is at night, loss by seepage is at its maximum and the spring-flow greatest. When, on the other hand, evaporation is most active, that is, during the warmer daylight hours, tree leakage is largest and spring-flow least, even to complete cessation by mid-afternoon, or earlier. Such is the course and the explanation of the well known, but to few familiar, night spring. In the course of a severe drought such a spring first becomes feeble by day, then flows only at night, and finally neither by day nor at night.

"From the explanation above of night springs it is clear that anything that suddenly would shut off tree evaporation would, during a period of dry weather, as promptly strengthen, or even start afresh, many a small forest spring. Clearly, too, the thing that does just that is the first killing frost of autumn. That is why at times and places springs start up anew, and branches flow again, or stronger at least, immediately after the first heavy frost in the fall of the year; and that, too, without any precipitation to supply the goodly quantity of water where but a day before there had been little or none."

Conducted by **JACOB DESCHIN**

The Focal Point

MANY subjects that we run across casually when wandering in search of pictures compose themselves naturally; others offer the opportunity for good composition, but must be arranged. Two examples of such opportunities, or "settings," are illustrated here. In each case, the photographer realized that he had a good setting, but needed a focal point to move in and make the subject complete.

Figures 1 and 2 were taken from the seventh story of an apartment building one morning after the street had been washed. The subject was almost obvious, and the

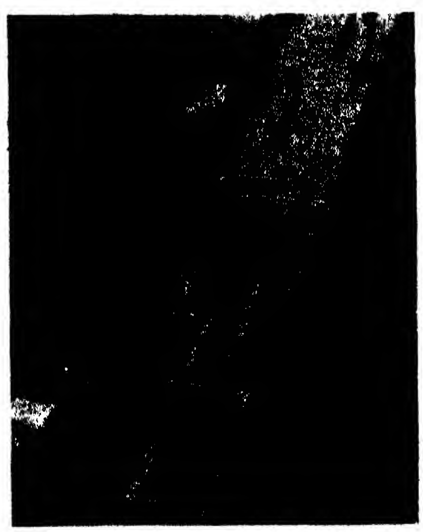


Figure 1

diagonal composition of the street imperative. But it took only a little study and a disappointing shot or two to make it clear that the important thing was not to include too many persons in the picture space and this conviction finally brought the photographer to the conclusion that by far the best picture would be obtained by having but one person and that person in the focal point at the upper right-hand cross-section of the compositional "skeleton," that is, one third of the way from the top and one third from the side.

A comparative study of the two pictures makes it pretty clear which of the two is the more attractive, and the stronger both as to content and composition.

Figure 3 is a typical shot experienced by the sea-goer. Water, water, everywhere, and no relief in sight. Many such pictures are made which include a more interesting sky than that shown in Figure 3 and in some such cases the picture is wholly satisfying, but in our particular case there is, somehow,

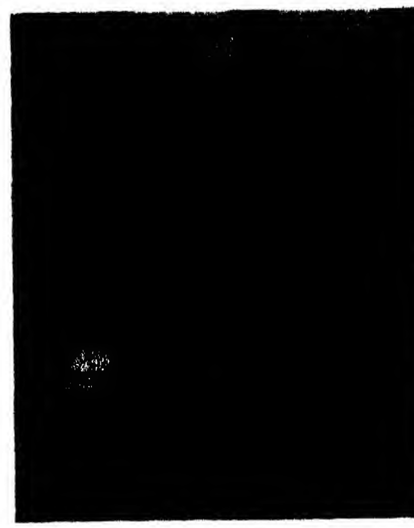


Figure 2

something lacking. We instinctively feel the need of an accent, a focal point to tie things together. Even so simple a thing as a sailboat (Figure 4) is sufficient to break into the expanse of sea and sky and bring the picture home to us.

The moral is plain. A focal point is essential, but in striving to introduce it into the picture pattern, beware of overdoing it—avoid confusion and meaninglessness. Work for simplicity, for directness. A small sailboat in the distance does not look like much in such a wide expanse as sea and sky, but see how effectively it does the trick in Figure 4. The impression of vastness and space is much more vividly portrayed in this latter picture than in Figure 3, although both pictures are the same with the single exception of the little boat.

Figure 3

Figure 4

The suggested treatments of the familiar subjects illustrated in Figures 2 and 4 may offer some clues to possible arrangements with similar "settings." The important thing to remember is that some point of emphasis must be included in order to make a picture out of a picture possibility, but that unless this point is properly arranged, through careful selection of available material, nothing is gained. To know what to leave out is just as important as to know what to leave in or to put in, and the individual judgment in such cases is very often dictated as much by instinctive feeling as by artistic perception or mere mechanical manipulation.

17,000,000 Camera Shooters

STATISTICS have been so rampant of late concerning the number of camera owners that it is a comfort to get the real low-down from an authoritative source, the identity of which, however, we are not at liberty to disclose.

We are informed that there are 25,000,000 cameras owned in the United States, 17,000,000 of which are in active use. This does not mean that there are 17,000,000 camera *owners*, for some own more than one camera. Camera clubs in the country total 3000. Of the cameras purchased, 40 percent are bought as gifts for friends and relatives; as to film, 80 percent is bought in drug stores, not camera stores. The leading camera type seems to be the box camera, the number of these in use being 50 percent of the total of all types. Also, 37 percent of the film consumed annually is shot in box cameras. Most pictures are made by married persons between the ages of 20 and 30; 90 percent of the exposed films are developed by commercial finishers; 50 percent of the pictures are snapped at home.

Backlighting

ONE of the illustrations shows both the illuminant—a spotlight—and the subject. Backlighting of translucent or semi-translucent subjects provides some of the most beautiful effects obtainable in photography. The most important precaution to observe is, of course, to make sure the light does not strike the camera lens directly. In the illustration, "Backlighting Method," it was possible to include both light and subject because the light source itself, the 500-watt projection bulb, was avoided by angling

"Backlighting Method"

the camera high enough for this purpose. Ordinarily, the camera is maneuvered to avoid the light altogether. Where the subject is larger than the light source, the latter can be placed directly back of the subject and the camera pointed head-on, because in that case only the light transmitted through the subject reaches the lens. A lens shade should generally be employed in this kind of work.

British Show Coming

THE complete pictorial section of the annual exhibition of the Royal Photographic Society, the last to be seen in the society's old premises in London, will be shown in New York City at the National Academy of Design. The 220 prints, nearly 60 of which represent American photographers, will be on display December 1 to 14, under the sponsorship of the Oval Table Society. The National Academy of Design will be host.

Resolving Power of Eye *vs.* Lens

BY a happy coincidence, Franklin W. Smith, of Thiells, New York, has made actual experiments, both celestial and terrestrial, on the question propounded by L.C.D. in the August Round Table; namely, whether a miniature camera could take a picture from a considerable distance and by enlarging the negative bring out a detail (such as a license number on a car) which the taker of the picture could not see with his naked eye at the time the picture was taken, assuming excellent eyesight.

"I became interested in that problem," writes Mr. Smith, "a couple of years ago and made some experiments to determine the answer. My first experiment was in the field of astronomical photography. There is a double star, Epsilon Lyrae, which is considered a good test of eyesight, being separated only by eyes possessing quite keen vision. I photographed this with a cheap miniature camera (having an $f/3.5$ lens of 50-mm focal length) by simply directing the camera toward that region of the sky at night and opening the shutter for a few minutes and allowing the star image to trail across the film. The trail obtained is very plainly double (when negative is examined under microscope). Thus, in this case the camera surpasses the eye in resolving power, but it must be admitted that it is a particularly favorable case because of the great contrast (between the sky and the sky background).

"When the trial was made on the terrestrial object it was not possible to get a satisfactory image even when just close enough to read the number with the eye. The limiting factor appeared to be the grain of the film (although I used Panatomic film and Eastman Ultra Fine Grain developer). I therefore repeated the experiment by photographing directly on glossy Azo paper (giving an appropriate exposure of a minute or so, as I recall it). I found that I could get a readable negative from the greatest distance at which I could read the number with the naked eye, *but no farther.* I repeated the experiment still using Azo paper but using a vest pocket Kodak with $f/7.7$ anastigmat lens of 83-mm focal length. With this it was possible to get better definition in the negative than with the naked eye.

"In summary, my conclusions are: Theoretically, the resolving power of a miniature camera lens should be better than that of the naked eye—in practice this is the case only when a very special object is photographed, that is, when the conditions are set up to favor the camera lens; The grain of the film rather than the defining power of the lens appears to be the limiting factor; A slight increase in focal length makes it possible to obtain the desired result."

Bad Weather?

A SUCCESSION of showers lasting several weeks recently broke many photographic hearts, but the wise ones looked for the silver lining and found it in such subjects as the one shown here. Raindrops on the window panes is one of the

"Raindrops"

charming compensations for a rainy day and is yours for the asking if you will be sure of getting the right viewpoint. In "Raindrops" it was necessary to take up a camera position that would provide a dark background for the subject. The two lower panes are the best for this reason, the highlights on the raindrops showing up brilliantly against the buildings. Notice how this effect is lost in the upper right-hand pane.

Is the Grass Really Greener?

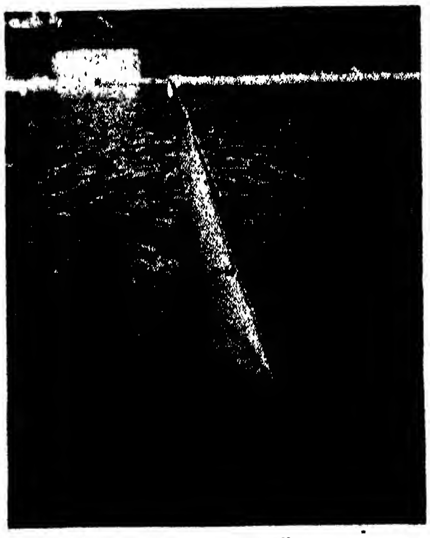
NO, says Mrs. Helene Sanders, of New York City, who, with her former teacher, Nicholas Haz, has just opened the Master School of Photography at Rockefeller Center in New York. Mrs. Sanders is one of only three women in the United States who are Fellows of the Royal Photographic Society of Great Britain.

"One need not go abroad to find wonderful material for photography," she says. "You have heard, have you not, about the artists' convention? The men from Vienna complained they had no material at home, for New York had all the skyscrapers, but the men from New York complained they were at a disadvantage because the men from Europe had all the beautiful old

buildings to photograph. The truth is, of course, that the artist will find material wherever he is—even in an ashcan, if he looks. I have lived in many parts of the world, but I have found nothing more interesting than the Catskills in the fall, when the leaves are beginning to turn, and Gloucester when the fishing smacks tie up at the old wharves. For skyscrapers and night photography, of course, no place can compare with New York."

Adventure on the Play Seas

THOUGH moving along the water entirely by grace of wind and sail, the little toy sailboats that are sent adventuring



"Homecoming"

over park lakes provide thrills for boys—and girls too—equal to anything in their play repertoire. Take your camera to the park lake some week-end afternoon and watch your chances for the graceful movement of these little giants of the play seas, for the striking resemblance some of them have in certain attitudes to the grown-up originals which these play boats attempt to imitate. "Homecoming" is an example of a shot made as the boat had almost reached shore and as it made a curving last spurt toward its destination. Close-ups of this sort will generally be found more interesting and worthwhile than shots of a group of boats.

There's Many a Slip

IT was a swell subject and the lighting was just right. The vantage point was carefully chosen—the foot of the subway staircase—and through the archway above stood the skyscraper in all its sunlit glory. The photographer had the time and the subject was patient, so why not make the most of the opportunity. Try it with a yellow filter first, then with a blue filter, a green one, a red one, this exposure and that exposure. The winding key (of the automatic stop type) moved rather freely, it seemed, but then. . . . In the darkroom everything turned black of a sudden, and it wasn't because the light was out. The camera was empty! And all that fine shooting was just for practice. However, the photographer who confessed all this to us, took it in good spirit. He didn't get any

pictures but he had had all the fun of shooting the pictures, so that all had not been lost after all.

Storing Cardboard

ODDS and ends of cardboard for mounts and other purposes are conveniently stored in the illustrated gadget. Its construction is simplicity itself and is evident from

For storing cardboard

the illustration; two strips of wood at the back and one at the front, although more may be used if required. The device is suspended from the molding with two ordinary picture hooks. Another use for the device is the storage of large photographic blotters.

Camera and Golf

FAULTS in your golf technique show up glaringly on a photographic negative. Harry Cooper, champion golf player, soon found that out in teaching the art of golf via the camera and in a recent issue of *Zeiss Magazine* writes:

"Very frequently all the explanations in the world will not put over a particular point in teaching, but a single picture, showing the fault in the swing, will get over your point so that the pupil will try to remedy it. In this instance, seeing is certainly believing."

Table-Topping Tips

WATER effects produced by sheets of crinkled Cellophane; jockeys converted from dime store cowboy figures; prison bars made of sticks of spaghetti, painted black; effect of suspended movement obtained by laying objects on a glass-topped table and pointing the camera down at them. Asparagus tips simulate exotic growths; skinned twigs simulate blasted oaks; piece of fur strewn with sand equals grass; tapioca used for cobblestones.

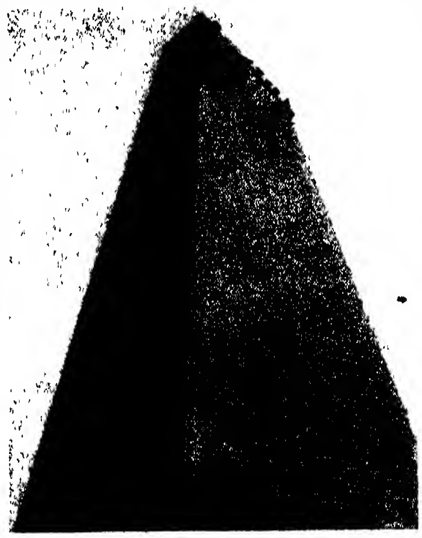
Bigger and Bigger

THE paradox of bigger pictures from smaller negatives continues to grow apace, the latest news in this vein being a Leica picture by Rudolf H. Hoffmann. The negative in question has been enlarged, in

lithographic reproduction, for service as an illustration for a roadside billboard advertisement, to seventeen thousand and a half times the area of the original negative!

Angles and Color

THIS department's recent preview around the site of the New York World's Fair presages a riot of angle shooting on the part of the droves of camera users who will invade the grounds. One of these will undoubtedly be the illumination tower reproduced here. Others will be the famous Perisphere and Trylon, which constitute the Theme Center of the exposition.



An angle on the future

Color enthusiasts are in for the time of their lives, for colors of various hues will dominate practically every feature of the Fair, both by day and by night. In fact, color pictures will be a must for the majority of shots, which in many cases will fall flat, or at least far short of the possibilities of the subjects, if "black and white" film is used.

Getting Places

"THE most wonderful feeling of all," writes Samuel E. Lesser, of New York City, "is the feeling that when I'm taking a shot I know what I am doing, know the result I'm after, know if it's possible to get that result. . . ."

Every camera user who has come a step away from the purely button-pushing, gee-I-hope-it-comes-out stage, knows what Mr. Lesser means and just how proud he must be. As a matter of fact, it seems to us that it is only when the amateur worker has reached this point that he can really begin to enjoy his hobby to the greatest extent.

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

PHOTRIX ENLARGEMENT CALCULATOR: Designed for finding required enlarging time after light from lens of enlarger has been measured with photo-electric meter.

Once emulsion speed of paper is known, calculator indicates negative density and magnification. Picture size scale up to 40 by 60 inches. Exposure time scale from 10 minutes down to 0.15 seconds. Variations in exposure time for flat or contrasty negatives indicated by lines engraved on celluloid pointer.

D+F COMBINATION DEVELOPER (24-oz., $1.40; 32-oz., $1.85): Combines developer and fixing bath in single solution. Developing-fixing time 15 minutes, with occasional agitation. Enlargements 5 to 6 times linear.

TENAX 1 inch by 1 inch (with Tessar $f/2.8$, $153.; with Sonnar $f/2$, $183): Short-throw lever advances film and cocks shutter with single, instantaneous movement. Uses standard 35-mm film in Contax daylight-loading spools, cartridges, or Contax metal magazines, making 50 negatives 24 by 24 mm on single loading. Standard lens focal length 4 cm. Interchangeable with standard lens is wide angle Orthometar $f/4.5$, 2.7 cm and telephoto Sonnar $f/4$, 7.5 cm. All lenses couple with built-in range-finder combined with large viewfinder. Lenses in bayonet mounts. Compur Rapid shutter with speeds to 1/400 second and built-in self-timer. Shutter release on top. Eveready carrying case, filters, and sunshade available. Weight, 21½ ounces. Dimensions, 2¾ by 3 by 5 inches.

MAXIM ENLARGING EXPOSURE METER ($2.95): Extinction type meter for determining exposure in enlarging. No moving parts. Sturdy construction. Movement about easel is unimpeded. Reading is direct.

POLYTHERMIC ALL-TEMPERATURE NEGATIVE DEVELOPER (24-oz. bottle, $1.35; 32-oz. bottle, $1.75): Features temperature flexibility and minimum grain. Maker claims for it ability to enlarge to 72 times linear with minimum of grain, great latitude and emulsion speed. Contains no paraphenylenediamine or any of its derivatives; is non-staining. One quart will develop 12 to 15 rolls of 35-mm film or equivalent.

SIMMON MODEL D OMEGA ENLARGER ($175 without lens): For negatives 4 by 5 and smaller. Rigid two-inch diameter steel post, 60 inches tall, long bellows and interchangeable lens board permit high-ratio enlargements: 5½ times with 5¼-inch lens (for 4 by 5 negatives), 20 times with 2-inch lens (for 35-mm negatives). Bellows maximum extension 11 inches permits pictures of reduced size; minimum draw 2 inches, allowing use of standard miniature camera lens. Dust-free negative carriers available in variety of sizes. Double condenser system, featuring special standard voltage 100-watt projection bulb, gives short exposures on slower enlarging papers. Built-in heavy-duty rheostat in cast alumin-

um housing at base of pillar controls light intensity. Dyna-Thermal ventilating system, with Bakelite lamp house, keeps negatives cool. Long 13-inch focusing lever and smooth operating mechanism provide focusing accuracy. Strong steel tape on enclosed spring reel counterbalances weight of enlarger head and duraluminum supporting beams.

KALART PRESS SPEED FLASH: A built-in mechanical synchronizer without wires and featuring automatic cushioned action; finger tip release from camera bed; combination reflector and battery case in single unit; adjustable reflector; quick-change socket; lamp ejector; three standard single-cell batteries; multiple lamp connector; remote lighting feature; two positions for reflector; weight one pound. Available for all models of Speed Graphic cameras.

KODACHROME ADAPTER FOR RECOMAR ($23.50): Consists of film chamber and ground-glass focusing panel mounted to slide on larger panel.

Larger panel fits Recomar back (and backs of some other film-pack cameras) when regular ground-glass screen or film-pack adapter is removed. Picture is focused on small ground-glass panel, film chamber then slid down into position and picture snapped. Film chamber takes eight-exposure K828 Kodachrome. Adapter may be removed from camera when roll is partly exposed. Possibilities: natural size images of flowers and tiny objects, moderate close-ups, portraits, telephoto shots because of long focal length of lens when using adapter. With each adapter is included: Table of effective *f*-values of different lens apertures for various lens-to-subject distances; factors for exposure increase with greater-than-normal extensions.

AMITOL PAPER DEVELOPER (16-oz stock solution, $ .60; 24-oz. stock solution, $ .85): Maker claims will not stain print even when latter has remained in bath as long as eight minutes. For brilliant effects, dilute 1 to 1, for softer results 1 to 2. Laboratory test results in one hundred 8 by 10 prints in only 16 ounces of stock solution before exhaustion.

RAYGRAM WEIGHT-SPOON ($1): Metal hand scale for weighing chemicals. Spoon is dipped into chemical and suspended from the hand on a chain. Counter-balance built into handle is adjusted for weighing up to 10 grams.

ILFORD PLASTIKA PAPER ($1.25 dozen 8x10; $2.50 dozen 11x14): Coated with bromide emulsion of medium speed and possessing long scale, this paper is said to "match the characteristic curves of modern negative materials, reproducing accurately every gradation of the negative" and providing

roundness and modeling to the image. Especially suitable for portraiture, architecture, and landscape photography. Latitude in exposure and development. Image color black "with just a hint of warmth." Medium speed of paper allows use for either enlarging or contact printing. Available in following surfaces: Glossy single or double weight, in soft, normal, and contrasty grades; matt double weight, grained half-matt double weight, and cream semi-matt double weight in normal or contrasty grades.

OMAC RANGE FINDER ($7.50): Two large fields, one colored light yellow for easier vision, brought into coincidence by means of large knurled head at right of finder; distance then read from calibrated scale beneath hairline rule in glass window. Long focal length gives large images. Attachment fixture fitted to bottom of range finder permits slipping into standard accessory foot of most miniature cameras. Bracket for attaching finder to any camera also supplied. Outside case of finder of Bakelite with no protruding parts.

F-R DEVELOPING KITS contain all the essentials for fine-grain developing. For the ardent camera fan as well as for the newer camera user—for the stay-at-home—for the camera-toting traveller. F-R 35-MM KIT ($6.95) contains 35-mm roll-film developing tank, tank thermometer, absorbent film squeegee, 8-oz. bottle concentrated X-33, 8-oz. bottle concentrated Fixol, two spring clips. F-R ROLL-FILM KIT ($8.95), adjustable for all sizes of film up to and including 116. Contains adjustable developing tank model C, tank thermometer, absorbent film squeegee, 16-oz. bottle concentrated X-33, 16-oz. bottle concentrated Fixol, two spring clips.

FELICE HOME DARK-ROOM CABINET ($29) makes it possible to do your dark room work in any room of your home, doing it without making that room look like a shop, and when you are finished, just turning on the lights, closing two doors (safety lock) and having your work cabinet turned into a handsome piece of furniture. Cabinet is a complete photo-laboratory in itself. Handles prints up to 8 by 10 inches; equipped with two porcelain trays and a 15" diameter scientific washer and sink combined. Also has one large shelf compartment for storage of trays and squeegee plates and four large drawers equipped with label holders for paper, films, negatives and various camera accessories. A large storage compartment is also provided for chemicals and equipment.

RAYGRAM TRANSPARENCY VIEWER, WITH HOLE PUNCH ($3.25): Permits convenient selection of 35-mm strip negatives and 2 inch by 2 inch transparencies. Open gate tracks for 8-mm and 16-mm available. Can be used with any standard splicer or rewinder. Focusing eye piece adjustable to individual sight range.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

***Q.* Recently, in examining the lens of my camera, I noticed small cobweb-like markings near the edges. Can you tell me the reason for this and what can be done about it?—L. E. S.**

A. These cobwebs, as you call them, are the result of the degeneration or drying up of the Canada balsam used to cement the lens elements together. These crystallizations will cause lack of sharpness in the negative and the defect must, therefore, be remedied. Take the lens to an optical company and have it re-cemented.

***Q.* Is Agfa Ultra-Speed Panchromatic Film for 35-mm cameras too fast for sunlight snapshots with an Argus camera with a speed of 1/200 of a second and the smallest stop of *f*/11? What are the possibilities of taking snapshots at night with regular electric light using this film in an Argus camera?—H. Y.**

A. This film belongs in the category of the fastest films available today and is intended chiefly for use under adverse lighting conditions or where high shutter speeds are required despite fair illumination. Of course, it may and is being used for all-'round purposes, both indoors and out under various conditions of light. However, outdoors in full sunlight, it would be very easy to overexpose and this might be caused under some circumstances even at *f*/11 and 1/200 of a second. Depending on the nearness of the light to the subject as well as the light intensity, the *f*/4.5 lens on your camera would often permit moderate snapshot exposure by artificial light indoors.

***Q.* (a) Using the same projection paper, and same aperture on the enlarger lens, should an enlargement of 8 diameters require 4 times the exposure of an enlargement of 4 diameters? Does the correct exposure time vary directly as the square of the magnification in diameters?**

(b) Using an enlarger lens with apertures of *f*/4.5, 5.6, 8, and 11, does each aperture require twice as much printing time as the next larger size? Is there much difference in the sharpness of focus with different aperture sizes when used for enlarging?—W. B.

A. (a) Theoretically it should, but it does not so work out in practice. The required increase in exposure is more nearly about 3 times, although the actual exposure time should be determined by test in the usual way; that is, test strip or enlarging exposure meter.

(b) The doubling of the printing exposure time for each smaller aperture is a good rough-and-ready method of finding differences in exposure at the various stops, but where best results are desired, an exposure test, as in the above case, will be needed. Inasmuch as the negative is a plane object focused on a parallel plane below (the printing paper on easel or baseboard), it is reasonable to expect that a sharp negative image can be focused sharply on the easel at the full aperture of the lens. However, a slight increase in sharpness may be noted at the smaller stops.

***Q.* When using a synchronizing flash attachment on a single-lens reflex camera, I have wondered if one is dazzled by the flash when looking down into the ground glass of the camera.—Dr. R. O. R.**

A. If the flash bulb is backed up by a reflector, as it should be in order to gain the full advantage of the illumination produced, light will go forward and will not affect the photographer. As for the ground glass causing dazzle, this is not possible for two reasons. First, the mirror must go up against the ground glass before the image can reach the film, at which time the flash simultaneously operates to provide the necessary illumination; second, even if you were using a twin-lens reflex camera and viewed the image during the exposure, the briefness of the flash and the fact that what the photographer sees is the reflection of the flash from the subject rather than the flash itself, would make dazzle impossible.

***Q.* Assuming that a person could time enlargements as accurately in the range of from ½ second to 1 second as he can in the range of 20 seconds to 40 seconds, would a perfectly timed print at ½ second have the same quality of a perfectly timed print at 20 seconds, the only difference being the intensity of the light; using the same film, same enlarging paper, and so on? Would it be prac-**

tical to use the shutter at, say 1/25 of a second in enlarging pictures onto a very fast enlarging paper and with strong projection light?—K. L. R.

A. Correct printing exposure time is purely a matter of the length of time—under given conditions of strength of light, distance of negative from paper on easel, density of negative, lens diaphragm opening, and contrast of paper being used; that is, the "speed" of the paper—required to produce a print of satisfactory quality. If this result is achieved at 1/25 of a second, as you suggest, or at the end of 40 seconds, we do not believe there should be any difference, all other factors being equal. Employing a shutter, which, of course, is not usually associated with enlarging lenses, "snapshot enlargements" might be fairly practical. Don't forget to turn out the enlarging light after each such exposure.

***Q.* I have been experiencing trouble in getting a background black enough to avoid reflectio' 'hat is the blackest black material available?—D. M.**

A. Black velvet is generally held by professionals to afford the blackest black background obtainable.

***Q.* I have a box camera taking No. 120 film and want to use it to make stereoscopic photos of still objects. This I plan to do by setting the camera in two slightly different positions, horizontally, and exposing two films. What I want to know is the distance to move the camera for the second exposure. I have an old stereoscopic viewer. I suppose the finished photos should be placed on a card the same distance apart as the camera was moved for the second photo. Is this correct?—G. B. A.**

A. The subject of stereophotography was discussed in general terms in the leading article of last month's Camera Angles. The method you propose for making stereos has been used with success by owners of box cameras as well as other types. Assuming that the lenses of your viewer are placed at the standard separation of 2⅝ inches, the camera is moved the same distance between exposures. One method employed with box cameras is to construct a wooden tray of such dimensions as to permit this separation when the camera is shifted for the second exposure. This method will also guarantee that the shifting will be done on an absolute parallel in relation to the subject being photographed. The finished pictures, cropped, if necessary, will be transposed and separated by 2⅝ inches, center to center.

***Q.* I have read that a cider vinegar solution should not be used as an acetic acid short-stop. Why not? I have been using it for several batches of prints and cannot see that it has done them any harm. I am going to try my hand at developing some 35-mm film soon. Would you advise using a more chemically pure short-stop for the film?—L. C.**

A. We hope you will pardon our candor, but we cannot quite see the point of going to the trouble of experimenting with liquids foreign to photographic practice when the real thing costs so little and has proved scientifically effective. The fact that your prints do not appear to have suffered from the cider vinegar short-stop bath is probably due to the brief period in which they were immersed in this bath prior to being treated to the regular acid fixing solution. The advice you have read against cider vinegar was prompted by the fact that this solution is much too dilute for the purpose and would tend to stain prints immersed in it. As for using such a solution in a short-stop bath while processing 35-mm film we must, once more in candor, throw up our hands in alarm. The processing of 35-mm film requires the greatest care and the use of chemically pure ingredients for acceptable results. Why take chances?

***Q.* Can you tell me if it is difficult to use the x x x camera (single lens reflex type) with the diaphragm stopped down to *f* 11?—A. J. K.**

A. When you speak of the usefulness of the x x x camera at *f*/11, we presume you are referring to the visibility of the ground-glass image at that stop. This depends, of course, on the general light conditions illuminating the subject at the time of taking the photograph. In bright sunlight outdoors and under certain favorable conditions of artificial lighting indoors, it is quite possible easily to focus on the ground glass at this opening.

***Q.* What is meant by film latitude?—D. K.**

A. This is the degree of error permissible in exposure without seriously affecting the chances of printable negatives. Modern films are said to have great latitude because they may be very much under-exposed or very much over-exposed and yet produce upon development sufficient density in shadow detail to make possible prints of satisfactory quality.

***Q.* When I take a picture I wind the shutter up for the next one. If I do not take a picture for a month or two would it do any harm to have the shutter wound up for so long without using it or would it be better after taking a picture not to turn for the next exposure until just before using?—H. V. K.**

A. The best procedure is to leave the shutter unwound when completing a picture-taking session. Otherwise, the shutter is working "over-time" and to no purpose. However, where you are making a series of exposures at relatively short intervals and particularly in the case of action photography where you must be ready to shoot at a moment's notice, it would be more convenient to wind the shutter after each exposure so as to be ready to shoot again quickly.

***Q.* Is there any remedy for water-spot marks on dried negatives?—L. J. K.**

A. The best remedy is, of course, the precautionary one of wiping the negatives clear of excess water before setting up to dry and then allowing the negatives to dry gradually in a warm atmosphere but without undue subjection to heat. However, water marks on dry negatives happen in the best of families and when they do, one remedy that has been used successfully calls for bleaching and redevelopment. The bleaching is done in a solution consisting of one gram of potassium dichromate, 100 cc. of water, and 2 cc. hydrochloric acid. After bleaching in this solution, re-develop the negatives in an elon-hydroquinone developer.

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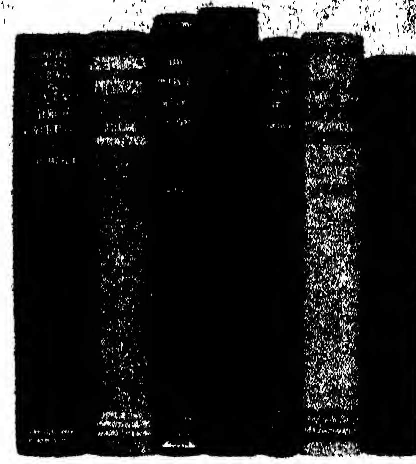

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

GLASS in several aspects pertinent to its use in telescoptics is the subject of this month's discussion, in the course of which we shall sweep up comments from several scientific journals not ordinarily seen by most readers.

ALL is not optical glass that glisters, but on the other hand not all that is not optical glass is contemptible. In a paper published in the *Journal of the Optical Society of America*, Vol. 28, No. 1, Dr. W. B. Rayton, of the scientific staff (lens designer) of the Bausch and Lomb Optical Co., makes some pertinent observations about this question:

"A Committee of this society spent many hours of discussion and carried out an extended correspondence in an effort to formulate a definition of optical glass without conspicuous success. Presumably such a definition should permit one to determine by inspection whether a sample piece of glass is optical glass or not. A definition in that sense is impossible. Certain specimens might be broken out of electric insulators that might, if judged only on a quality basis, be classed as the finest optical glass while other specimens of glass, very difficult to produce at all because of the extraordinary optical properties prescribed, would be immediately classed as ordinary glass of poor grade.

"In the consumer's mind, bubbles in glass are very offensive although from the optical standpoint they are the most harmless thing in the world. Bubbles are due to the volatilization of some of the materials in the batch in the melting process and because of greater viscosity they are held by some glasses much more tenaciously than by others. The manufacturer would like to take advantage of the more desirable optical properties of these glasses many times when he is compelled to use a less desirable glass because it is free of bubbles. Because of the refusal of the consuming public to accept bubbles in glass, he pays more for optical instruments than would otherwise be necessary and sometimes has to accept inferior performance.

"The best glass today absorbs not more than four to six tenths of a percent per centimeter except in the dense barium crowns and the densest flint glasses.

"Regarding the development of a sort of metallic luster generally known as tarnish: H. Dennis Taylor discovered to his surprise years ago that tarnished surfaces had a greater light transmission and a lower Fresnel reflection than clean, freshly-polished surfaces. Except for the appearance, then, which creates uneasiness in the mind of the owner or sales resistance in the prospective purchaser, this effect is not serious."

IN the same number (an optical glass number) of the journal named, George W. Morey, of the Geophysical Laboratory, Carnegie Institution of Washington, an optical glass expert, makes this statement: "Ordinary window glass today is of better quality than some pre-war optical glass, chiefly because of the reduction in iron content of the sand."

Incidentally, in the same article he mentions an interesting list: "Besides the eight disks supplementary to the 200-inch, all of which are of 'ribbed' structure, and one of which, the 120" flat, is larger than any disk previously made, there have been made in Corning seven solid type disks for reflecting telescopes. These are: a 24" for Cornell University; a 30" and a 36" for the Foundation for Astrophysical Research; a 60" for Harvard University; a 76" for the University of Toronto; an 81" for McDonald Observatory, Texas; and a 98" for the University of Michigan."

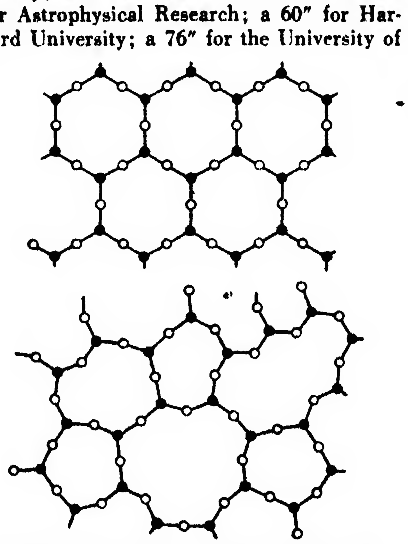


Figure 1: Crystal versus glass form

CONTINUING our gleanings on glass from recent technical papers, we take the following from an article on the X-ray determination of the structure of liquids and glass, by Dr. B. E. Warren, a Massachusetts Institute of Technology physicist who specializes in the X-ray study of the arrangement of the atoms and molecules of matter, published in the *Journal of Applied Physics*, Vol. 8, No. 10:

"Glass is usually called an under cooled liquid, the name suggesting that, although it has many of the mechanical properties of a true solid, it differs from the crystalline form of matter by not having passed through a sharp or definite transition in solidifying from the melt. From the X-ray studies we shall conclude that glass and liquids are similar in that both are amorphous forms of matter. In one respect, however, their structures differ; in a glass each atom has permanent neighbors at a fairly definite distance, while in a liquid the neighbors about any atom are continually changing."

HOW the atoms are arranged in matter has been fairly well worked out within recent years by X-ray analysis. This is not to be confused with ordinary X raying but consists of using X rays as "feelers" for the atoms. X rays are light having about 1/10,000 the wavelength of the light which our eyes perceive. Thus they get down into the realm of actual atom size. If light of this short wavelength is shot into matter, a part of it will be reflected from or diffracted by individual atoms and the emerging rays can be photographed. (The rays which pass on through in the commonplace X-ray manner are ignored.) If the atoms are arranged in a pattern, as in crystals, the photograph taken proves also to exhibit a systematic pattern. By means of this research tool physicists during the past few years have been able to ascertain at least as much concerning the atomic arrangement within matter as a blindfolded man could determine about the arrangement of objects in a box by feeling around within it—almost as much as if it were directly visible. In fact, the extent to which this technique has been developed and the complication of existing atomic arrangements revealed by it are remarkable. For most practical purposes, then, we can now "see" the atoms in matter as satisfactorily as we can see the rows and cross rows of trees in an orchard (though we cannot see individual atoms). And it has turned out that most common things are crystalline: wood, for example—even rubber!

But glass is an exception—it is amorphous. Before the X-ray technique was devised we were partly sure that glass was amorphous but could not prove it so directly as now. And in the *Technology Review* (Vol. 39, No. 6), edited at the Massachusetts Institute of Technology, Philip M. Morse shows what glass is like. Largely, he also points out, it has been the same Professor Warren, quoted some distance above, who has done research on the X-ray patterns and atomic arrangement of amorphous materials including glass. In these the regularity and symmetry of atoms existing in crystals are absent. However, the atoms remain about uniform distance apart, and Figure 1, reproduced from the review named, gives an idea of the difference in atomic arrangement of the same substance (B_2O_3 is the example chosen), first in its crystalline form (above) and then when turned into borate glass (below). "A glass," Prof. Morse says, "is a clumsy caricature of a crystal of the same material, distorted and with parts left out here and there."

COGNATE with all this is the fact, recently discovered by the same X-ray diffraction method, that even liquids, including water, have some orderliness of atomic arrangement. Debye, the German chemist, states as a result of his researches that liquids are much more closely related to solids than they are to gases.

JUST what happens when glass is polished? This is discussed in "ATM," pages 326-331, but since that note was written considerably more experiment has been performed and the subject has waxed in interest among physicists—particularly because we now have the X-ray method described above.

Let us first summarize the several com-

posing theories of the nature of polishing.

First, the theory of Newton and the younger Herschel: Polishing is nothing more than grinding or submicroscopically scratching down the protuberances with smaller and smaller abrasives until, as Newton put it, the visible "scratches and frettings of the surface become too small to be visible." Thus there is no essential difference between grinding and polishing. A theory of Elihu Thomson's, described in "ATM," page 328, is a relative of this one: the rouge particles embed themselves in the pitch, their cutting edges coming automatically to a common level, and make submicroscopic scratches. (Perhaps this explanation makes more appeal to the common sense than any other, but more recent evidence indicates that Theory 3, below, is closer to actual fact.)

Second, Rayleigh's theory that the operation is a molecular one. No pits are formed, as in grinding with hard surface against hard, by the breaking out of fragments, but the material is worn away, at first on the eminences, almost molecularly. The microscope shows that, as soon as the polished local areas can be observed at all, they appear absolutely structureless. In its subsequent action the polishing tool extends the boundaries of these parts but does not enhance their quality (paraphrased from Rayleigh, *Trans. Opt. Soc.*, Oct., 1917).

Third, the "butter" theory of Beilby, whose experiments threw an entirely fresh light on the nature of polish. He demonstrated smearing or flowing of the surface layer. Polishing at right angles to scratches caused a flowing that filled up and hid the scratches. Etched with hydrofluoric acid, the polished surface again revealed these scratches.

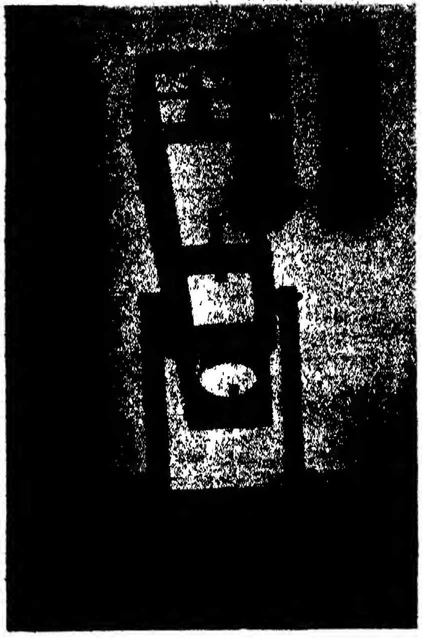
"The rouge particles hardly penetrate below the surface," Beilby states, "but, coming into almost molecular contact with the sheet of molecules on the surface, drag it off like a skin. The fresh molecular layer left by the removal of the skin retains its mobility for an instant, and, before solidification, is smoothed over by the action of surface tension, thus producing the liquid-like surface which is the necessary condition of a perfect polish."

Commenting on this, Selby says: "In many respects glass is a liquid of extremely high viscosity—not a solid. Energy expended in polishing is manifested by heat which is sufficient to lower the viscosity of the glass near the surface to such a degree that this hyperthin film—'beta layer'—can be made to flow." While heat is not a factor in the theories of Beilby or of French, it is in those of Macaulay of the Royal Technical College at Glasgow, also of Bowden and Hughes of Cambridge University. The latter two made experiments using two different metals as a thermo-couple and showed that in their sliding contact the surface temperature may be very high; in glass it would be still higher. (Letter from A. W. Everest: "I am beginning to lean toward plastic flow in polishing. I read an excellent paper pointing out the high temperatures generated in polishing—high enough in a thin layer of glass at the surface actually to melt it. If this is true, then of course plastic flow occurs. However, I still feel that most of the glass is *removed*.")

H. H. Selby, author of the chapter on flat making, in "ATMA" and a chemist, next describes his own experiments:

"Glass and light have one thing in common—dual personality. Only by assuming

THE BEGINNER'S CORNER



BETTER than to attempt to work out a perfect design for the beginner's first telescope is the alternative method of building something quite plain and simple, using it for a few weeks and then, in the light of that experience, working out something more permanent for the same optical parts. The tyro may rest assured that the two telescopes will differ considerably. Ideas that work well on paper will give way to ideas that work well in practice.

The simple mounting shown at the left above was made of wood, an easy material to work, by L. R. Pinson, 1746 S. Mansfield St., Los Angeles, Calif. The mirror is 6½" in diameter and, with the eyepiece seen protruding at the right, the telescope magnifies 60 diameters.

The mounting of the other telescope shown is an improvisation from an old lawnmower, some blocks of wood and standard pipe fittings. Not so simple as the other, it still is simple. The main axis is placed parallel with the axis of the earth, making of the telescope an equatorial type, as explained in the handbook of the hobby, "Amateur Telescope Making." A handscrew on the jackshaft at bottom permits a star to be slowly followed as the earth turns. The internal gear of the mower wheel was made use of for this purpose. The maker is the Rev. Harold F. Palmer, of the Immaculate Conception Church, Goliad, Texas. Father Palmer writes:

"About four months ago I accidentally picked up a copy of Scientific American and read your department, 'Telescoptics'. It was a revelation to me. Always interested in astronomy, I long ago gave up hope of ever having a telescope of my own. I bought a 6" kit of materials and after some three weeks (about 50 hours actual labor), I constructed this telescope. But the picture shows only the outside. Inside are to be seen the rings of Saturn, and many others among the beautiful sights in the sky.

"I cannot say that I experienced any special difficulty in grinding and polishing the mirror. It gives what to me seems excellent definition. But I shall not rest satisfied until I have constructed a 12", with accurate slow motion and setting circles."

TELESCOPTICS

(Continued from preceding page)

that light is both corpuscular and undulatory can some optical phenomena be explained. So, in a way, must glass be considered to be in some respects solid, in others, liquid.

"For years, the several theories of polish have had their advocates, who have been engaged among themselves in acrimonious polemics and contradictory experiment. A year or so ago, the Lowers and the writer did all but take to poniard and rapier over the matter. The Lowers discounted the beta film (butter) theory of Beilby and of French and the abrasion theory of Rayleigh, but held to the planing, or imbedded particle, idea. The writer clung piteously to a combination of planing and surface flow as best describing the polishing of glass. As practical evidence, the Lowers offered the observation that the polishing liquor became less red and more white as polishing proceeded, claiming that the color change was due to removal of glass from the surface and suspension in the liquor.

"In an attempt to test this assumption, an $f/1$ sphere was polished face up for 14 hours with a pitch lap and all the rouge liquor was saved for chemical analysis. If the Lowers were right, the solids suspended in the liquor should be quite high in silica (SiO_2), since the glass used was a mixture of the oxides of sodium, calcium and silicon. If, however, the writer's contention that the color change was due to emulsification of pitch constituents was correct, very little SiO_2 would be found.

"884 ml. (approximately 1 qt.) of liquor was evaporated to constant weight at 105° C. Thus, the water, turpentine, and other volatiles were removed. The residue weighed 47.408 gm. This was ignited to constant weight at 850° C. to remove the gums, resinates, etc., of pitch. This second residue was 44.971 gm.—a loss of 2.437 gm. A 5-gm. aliquot was then treated with hydrochloric acid, as in the usual SiO_2 determinations, and the treatments continued until the washings were free from iron. (The washings removed were examined nephelometrically and found free from colloidal SiO_2.) The residue of silica, ignited, weighed but 0.0174 gm. over and above the SiO_2 found in pure pitch (.0011 gm.), acid (.0003 gm.), rouge ([illegible] gm.) and water (.0000 gm.), run as controls.

"The above results indicated that the rouge liquor was not whitened by glass, for an equivalent amount of SiO_2, as glass dissolved in alkali and precipitated by acid, had no effect, nor did ten times that amount, as silica gel, silex, diatomite or tripoli. However, this experiment helped very little in elucidating the question of the theory of polish, since it merely indicated, nay, proved, that some glass was *removed*—it did not show that no flow occurred.

"Another experiment was undertaken, therefore, to shed some light on the flow question, for the writer has reason to consider glass as a supersaturated solution of normally crystalline silicates which cannot crystallize due to the very high viscosity of the solution. (On a scale in which water = 1, some glasses, even melting, would run to a viscosity of 10,000,000.)

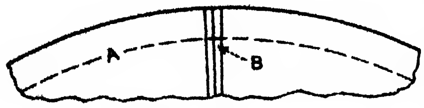


Figure 2: Selby's experiment

"A 15 cm. flat, 23 mm. thick, was very finely marked with radial grooves 4 cm. long, using a tungsten carbide pencil (Figure 2). The grooves were made in a lathe chuck, in triplicate, by drawing the spring-loaded pencil outward between guides, using kerosene as a lubricant. After many trials, smooth grooves were cut, the depth of which could be measured along the circle *A*, using the fine adjustment of the microscope, which could be read to 0.001 mm. Also, the thickness of the disk could be measured at *B*, using a micrometer calipers graduated to 0.01 mm. and readable to 0.001 mm.

"It was assumed that surface flow would be proved if a series of grooves of a given depth could be obliterated before the disk thickness had been decreased by a similar amount. Such proved to be the case.

"A typical pair of cases follows: (Each measurement was repeated ten times, 24 hours after last polishing period, at a constant temperature ± 1°C. and the average value reported.)

A. Hard pitch, 5% rouge suspension, 2 meters per min. Pressure, 0.3 Kg./sq.cm. Each wet dried.

3 grooves, av. depth 0.023 mm. obliterated in 22 wets. Thickness change 0.008 mm.

B. Hard pitch, 15% rouge, 2 M./min., 0.02 Kg/sq.cm., no wets dried.

0.011 mm. grooves obliterated in 60 wets. Thickness change 0.007 mm.

"The above trials, among many others, were repeated three times, with results of the same order of magnitude.

"The writer draws the following conclusions:

1. Surface flow does occur during pitch-polishing.
2. Glass is, at the same time, planed away.
3. Under the usual conditions of figuring (low pressure and thick rouge mixture) planing predominates, almost to the exclusion of flow.
4. Under rough and rapid polishing conditions, surface flow is marked and performs the major part of the polishing."

ON reading much of the literature about polish one conclusion becomes evident: an oversimplified answer will never do.

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Detective Stories

DETECTIVE stories were involved in the defense of a recent suit for trade-mark infringement. The plaintiff in the suit was engaged in the business of selling men's clothing at retail under the trade mark "Finchley" and it was established that the plaintiff had used the trade mark for many years. The defendant had recently commenced to use the trade mark "Fay Finchley" on women's clothing and the plaintiff charged that defendant's actions constituted trade-mark infringement. The Court concluded that the use by the defendant of the trade mark "Fay Finchley" on women's wearing apparel constituted infringement of the plaintiff's trade mark "Finchley."

In the course of the proceedings it was argued in behalf of the defendant that the defendant selected the name "Fay Finchley" because he had "read in numerous detective story magazines of Finchley Common, located outside of London, the favorite haunt of the notorious bandit, Dick Turpin."

In its opinion the Court referred to this argument, stating:

"Whether the activities of the latter (Dick Turpin) suggested the appropriation of which the plaintiff complains, is not the subject of discussion in the defendant's brief."

Procrastination

COPYRIGHT law is purely statutory and one seeking the protection of the law must comply strictly with the statute. To obtain a copyright on a published book the book must first be duly published with proper notice of copyright affixed thereto. The statute provides that thereafter two copies must "be promptly deposited in the copyright office or in the mail addressed to the register of copyrights." The statute further provides that until this provision is complied with no action or proceeding shall be maintained for infringement of the copyright.

In a recent case the publisher of a monthly magazine had affixed notice of copyright to one of the issues of the magazine but had failed to deposit the copies with the register of copyrights until after a lapse of 14 months. In the interval between the publication of the magazine and the deposit of the copies a book publisher published a book containing material substantially identical with an article appearing in the magazine. After the magazine publisher had deposited the copies with the register of copyrights he brought suit for copyright infringement against the book publisher.

The publisher of the book contended that the magazine publisher had failed promptly to deposit copies of the magazine with the register of copyrights as required by law and that he was barred from bringing suit. The Court pointed out that the purpose of the requirement of deposit was to enable publishers to determine whether they were infringing any existing copyrights. Since the book was published prior to the deposit of copies and since the delay in depositing the magazine copies was really substantial the Court held that the magazine publisher had failed to comply with the statute and was deprived of his remedy.

Converted Converter

THE uninitiated may have difficulty in distinguishing between a manufacturer and a converter of textile fabrics. Apparently, however, there is an important distinction in the textile industry. A converter is a person who purchases textile fabrics from a manufacturer and then sends them to another concern for finishing, bleaching, dyeing, or printing.

In a recent case a Federal Court affirmed the right of the Federal Trade Commission to order a converter to cease and desist from even indirectly indicating that he was a manufacturer. In the case in question a converter had been engaged in business for many years under a name which included the words "Mill Manufacturing Company." The Federal Trade Commission contended that the words "Mill" and "Manufacturing" indicated that the converter maintained a mill and was engaged in manufacturing fabrics. The Commission found that the purchasing public preferred to purchase fabrics directly from a manufacturer or mill as distinguished from a converter and that accordingly the converter was misleading the public and obtaining an unfair competitive advantage. To correct this the Commission issued an order requiring the converter to cease and desist from using the words "Mill" and "Manufacturing" in its name.

On appeal to a Federal Circuit Court of Appeals, the Court reviewed the findings of the Commission and held that the Commission was authorized to guard the public against dangers arising from misleading names. In the particular case, however, the Court pointed out that very little business was done with the purchasing public and that most of the merchandise was sold to retailers or to garment manufacturers who were well aware of the nature of the converter's business. The Court then stated that the converter's name had been used in good faith for many years and was of excellent repute. Under the circumstances the order of the Commission was considered too drastic and it was modified so as to permit the use of the words "Mill" and "Manufacturing" but so as to require the converter to place after its name the statement: "Converters, Not Manufacturers, of Textiles."

Author by Proxy

THE interpretation of the word "author" was involved in a recent suit for copyright infringement involving a music publishing company who had hired a musician to arrange certain musical compositions. The compositions thus arranged were copyrighted by the publisher. Thereafter the musician died and, upon the expiration of the copyrights, his son renewed them. The copyright law authorizes the renewal of a copyright by the author if he is living, or, if he is dead, by his widow or children.

In the case in question the renewal of the copyright was held to be invalid. The Court pointed out that the music publishing company hired the musician to arrange the compositions in question and that the word "author" as used in the copyright statute included a person who hired another to create a musical production. Since the renewal of a copyright must be taken out by the author, if living, and since the author was the publishing company the Court held that only the publishing company could renew the copyrights.

This case indicates a sharp difference between the copyright and patent laws. Under our patent laws an inventor is a person who conceives of and completes an invention. A person who hires another to make an invention is not an inventor. As seen above, under our copyright laws a person who hires another to create or compose a literary, musical, or artistic production is an author and may copyright the production.

Contempt Disclaimed

WHERE a claim of a patent has been declared invalid by a court of competent jurisdiction it is necessary for the patentee to file in the Patent Office a disclaimer of the invalid claim within a reasonable time after the adjudication. This principle of patent law was recently invoked to protect a defendant from being adjudged in contempt of court. Suit had been brought by a patentee against an infringer. The Court had found one of the claims to be valid and infringed while the remaining claims were declared invalid. Pursuant to its findings the court issued an injunction restraining the defendant from infringing the valid claim.

Approximately 20 months thereafter the patentee charged that the defendant violated the injunction and instituted proceedings to have the defendant adjudged in contempt of court. The defendant pointed out that the court had previously held all of the claims with the exception of one to be invalid and that even though 20 months had elapsed between the adjudication and the institution of the contempt proceedings the patentee had not filed a disclaimer of the invalid claims. It was argued by the defendant that the plaintiff had not filed a disclaimer of the invalid claims within a reasonable time and accordingly could not enforce its patent rights. The Court sustained the defendant's contention stating:

"Considering all the factors involved, I am of the opinion that plaintiff has allowed an unreasonable time to elapse without taking advantage of the disclaimer act * * * and the patent has therefore become void."

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SCIENTIFIC AMERICAN

ADVERTISERS

December · 1938

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City
Western Advertising Representatives

EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill

BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D MUNN, President JOHN P. DAVIS, Treasurer I SHELDON TILNEY, Secretary

Vol. 159, No. 6, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid. Illustrated articles must not be reproduced without written permission; quotations therefrom for stock-selling enterprises are never authorized. "Scientific American" registered United States Patent Office. Files are kept in all large libraries and articles are indexed in all leading indices.
Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

Date of Issue	Date of Issue	Date of Issue

GIPNLK—H-40 I.A.R.I.—29-4-55—15,000